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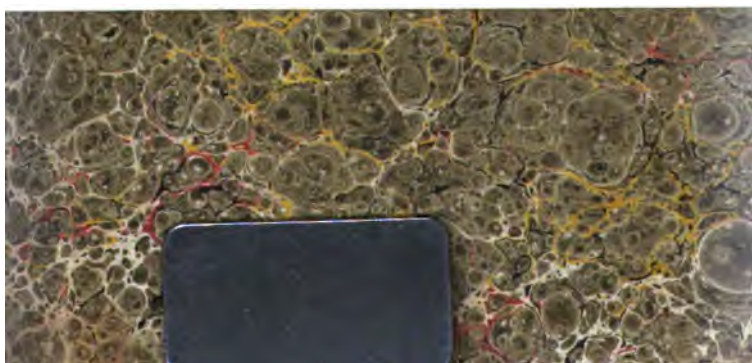
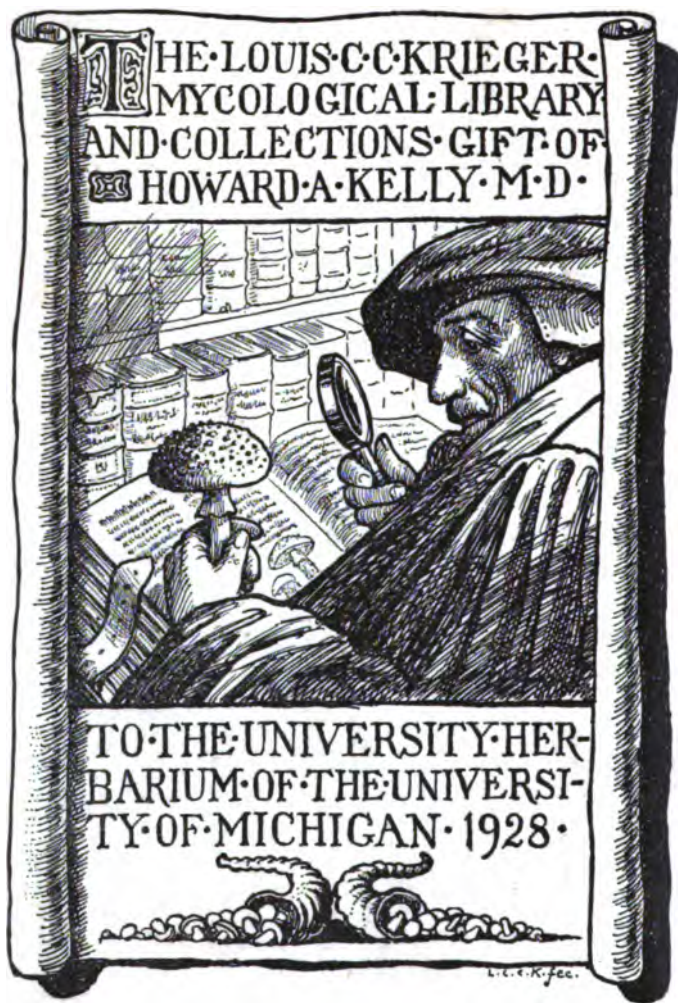
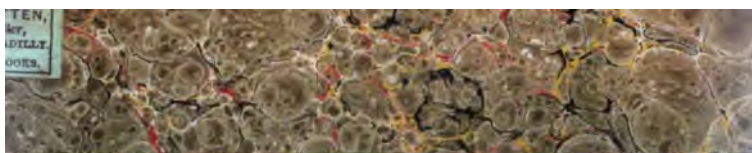
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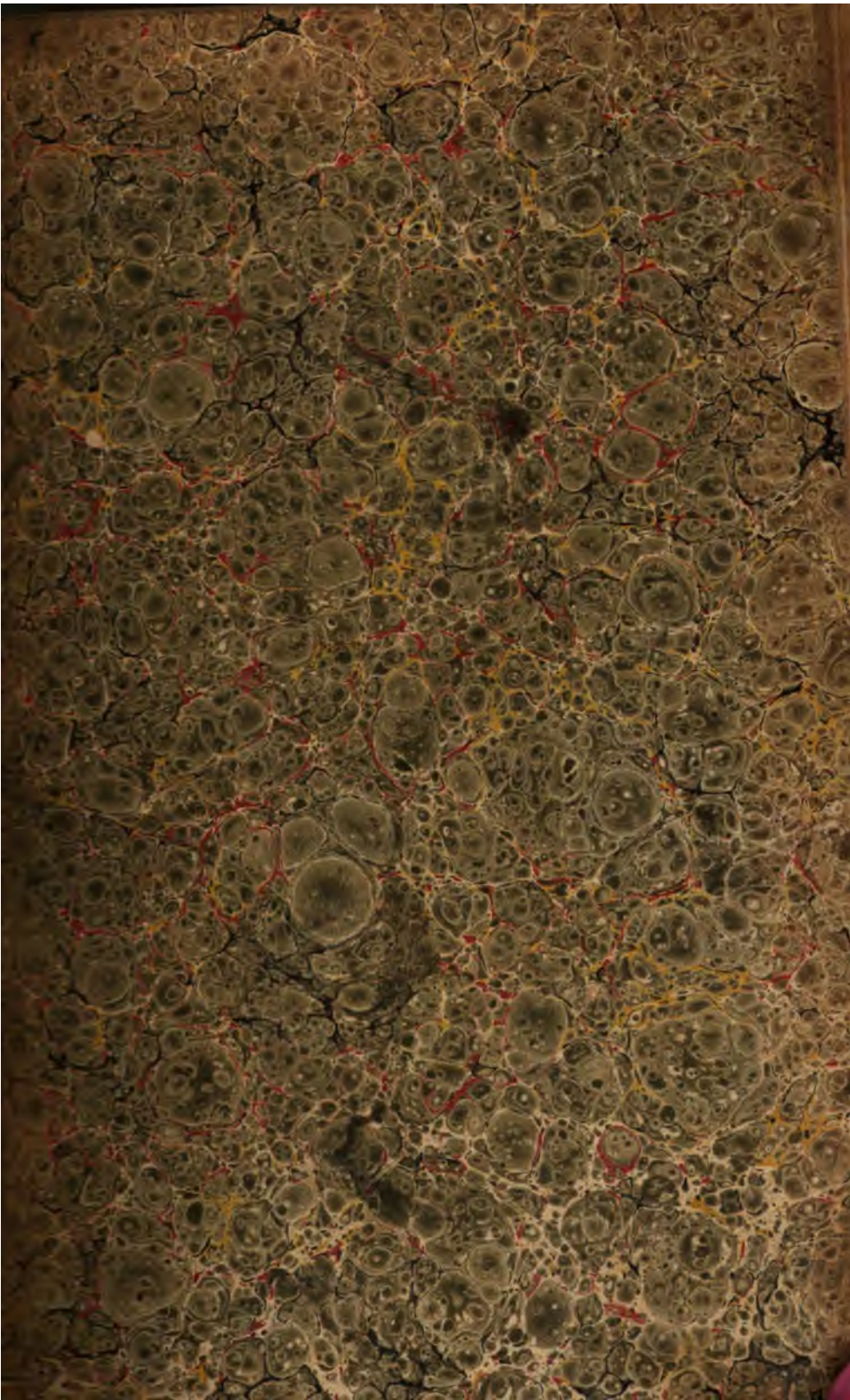
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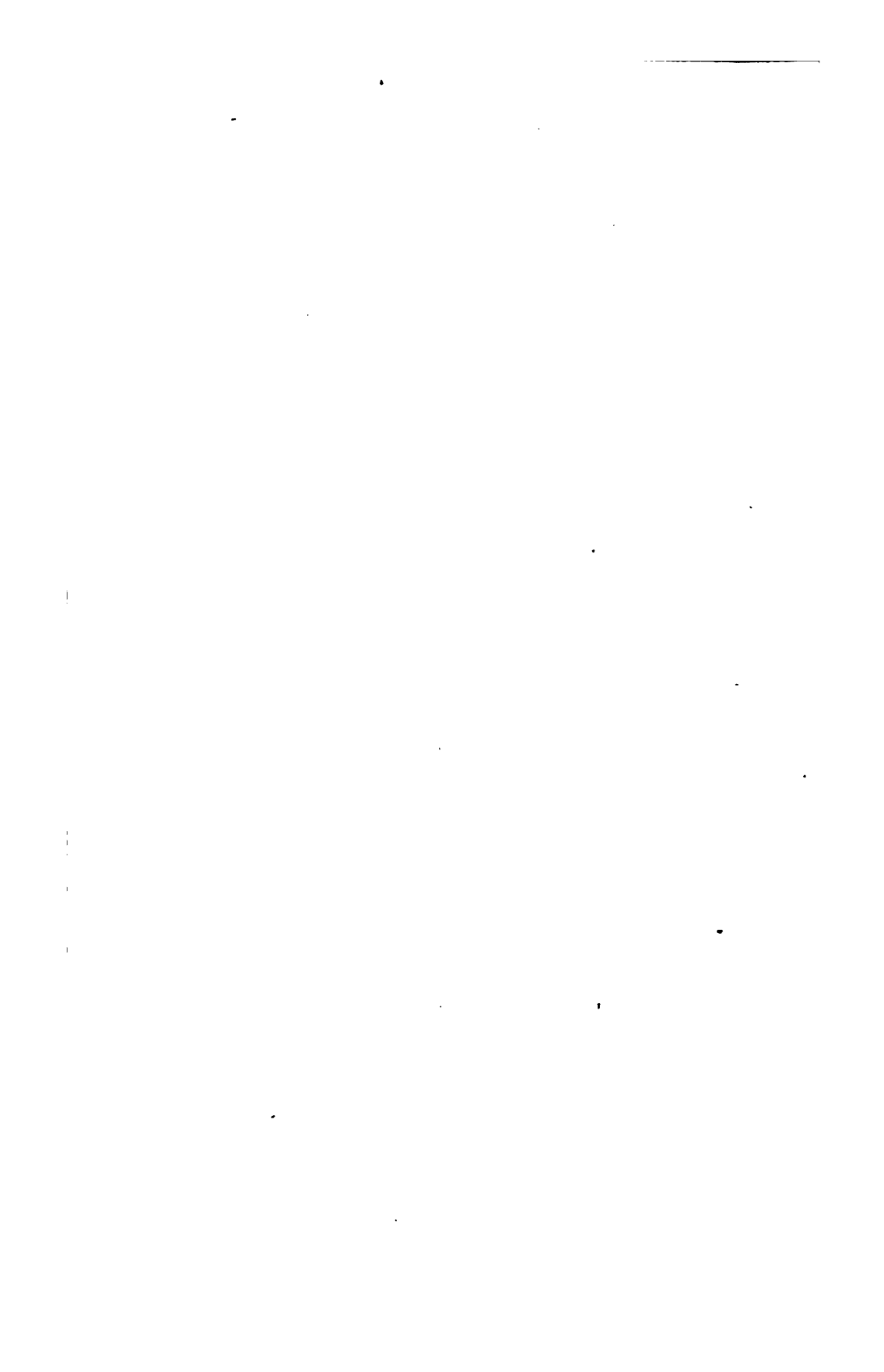
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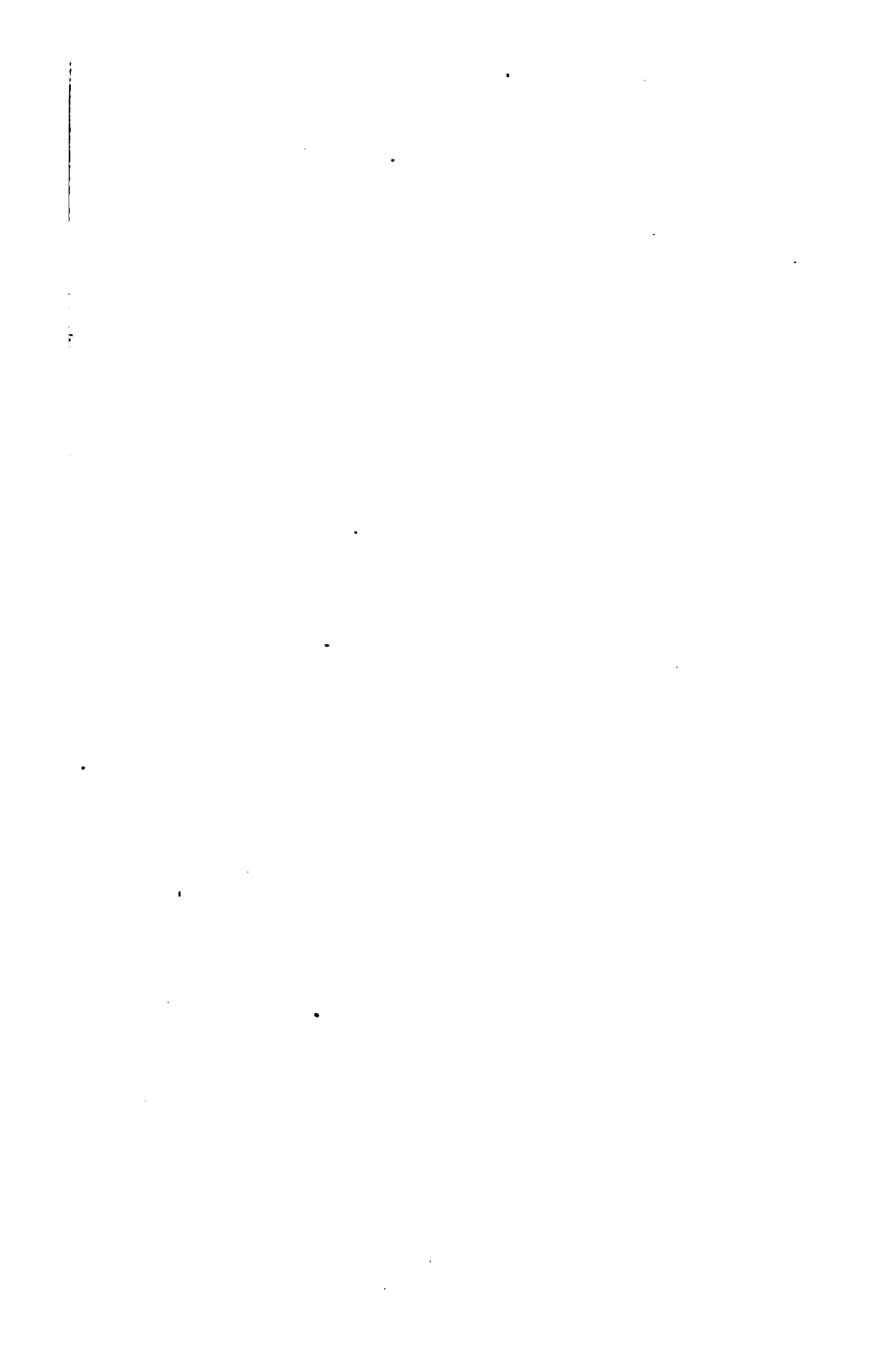
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*to G. F. Batty Esq^r
with the Author's
friendly regards.*

AN
ESSAY
ON THE
PROBABILITY OF SENSATION
IN
VEGETABLES,
&c.

*to G. F. Bultz Esq^r
with the Author's
friendly regards.*

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AN
ESSAY
ON THE
PROBABILITY OF SENSATION
IN
VEGETABLES;
WITH
ADDITIONAL OBSERVATIONS
ON
INSTINCT, SENSATION, IRRITABILITY, &c.

By JAMES PERCHARD TUPPER, ✓

MEMBER OF THE ROYAL COLLEGE OF SURGEONS, AND FELLOW OF THE
LINNEAN SOCIETY.

"FABA EST COGNATA PYTHAGORÆ."
Cicero.

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TO
JAMES EDWARD SMITH,
M.D. F.R.S. &c.

PRESIDENT OF THE LINNÆAN SOCIETY.

Dear Sir,

IN an age like the present, when knowledge is cultivated by such able hands, and when every branch of science flourishes with so much vigour, the fruit of my humble labours would have been laid aside, if your flattering opinion had not stamped a value on it far beyond my estimation of its worth.

Encouraged by such approval, I offer the same to the world, and feel proud

of the opportunity of expressing, publicly, the grateful sentiments which I retain for that source of scientific recreation which was opened in my mind under your public tuition, and improved under the auspices of your private friendship.

That you may long live to enjoy the laurels which you have gained in the field of science, to the improved cultivation of which you have so much contributed, is the sincere prayer of,

*Dear Sir,
Your much obliged friend,
and very faithful servant,*

James Perchard Tupper.

LONDON,
November 1st, 1811.

PREFACE.

SOME of the observations contained in the following Essay were thrown together at the time when the Author was a student at the hospitals of St. Thomas and Guy, and a pupil of Doctor Smith, by whom the Botanical Chair in that school was so ably filled.

Those observations were chiefly confined to a general view of the analogies between the animal and vegetable systems, and were laid aside

in that state for a considerable time. The subject, however, being a very interesting one, the author has been induced to take it up again as a source of amusement during the occasional leisure of his professional avocation ; and in so doing, he has carried his inquiries rather beyond their original extent. But these inquiries embrace metaphysical disquisitions of which the author was not aware when he first took up the pen ; and to such disquisitions he feels his abilities very unequal. If, therefore, he should fail to create that interest, or to afford that amusement, which the title of his Essay may lead to ex-

pect, he trusts that his endeavours will meet with some indulgence from the intelligent critic. And as the disappointed reader will not have had to travel through the maze of an unwieldy volume in pursuit of what he could not find, he will perhaps solace himself with the idea, that although he might have employed an hour more usefully, he might, at least, have thrown it more idly away.



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AN
ESSAY
ON THE
PROBABILITY OF SENSATION
IN
VEGETABLES.

" ————— in a doubtful theme
Engaged, I wander through mysterious ways."

ARMSTRONG.

It is as difficult to ascertain the nature of vegetable existence, as to determine what constitutes the living principle of animals. It is evident, however, that *life* is intimately connected with a particular

organic structure of parts ; for through the medium of that organization existence itself is preserved.

The physiologist who investigates the laws which regulate and direct all the different movements of the animal machine, cannot observe without admiration its wonderful fabric, which, from a mere "*rudis indigestaque moles*," the secret-working hand of Nature has elaborated into so complicate a form, every part of which is most exquisitely finished, and the whole so well and skilfully arranged as to constitute a being capable of giving existence to others similar to itself.

Although the vegetable physiologist may not have more to engage his attention, yet he has not less to admire. How widely and wonderfully different is the mature vegetable from the seed which

gave it being ! How great the contrast between the diminutive acorn and the stately forest-oak ! The seed is seemingly nothing more than a mere homogeneous substance ; but, when placed within the influence and operation of particular causes, its *latent* vital principle is called forth into action, a variety of organs are unfolded, and by successive evolutions the plant arrives at that state which constitutes the perfection of its nature, when, like animals, it is also endued with the power of propagating its species.

Naturalists have arranged all kinds of matter under three general classes ; the *Animal*,—the *Vegetable*,—and the *Mineral*. Those substances which belong to this last department being more particularly subject to the laws of chemistry, and having only an arrangement of parts

without organization, may be easily distinguished from animals and vegetables; but the line of separation between these two last is not so readily ascertained.

From man down to the most humble plant the distance is immense; but yet the whole of it is occupied by an innumerable diversity of beings, every species of which progressively descends below another in regard to the excellence of its attributes and the extent of its powers. And so gradual is this descent throughout the whole system of living beings, that the most inferior of a species resembles in many respects the most perfect of that which is next below it. Hence the transition from the animal to the plant is effected by shades so imperceptible that it is difficult, and perhaps impossible, to determine what are

those beings which actually form the last link in the scale of animal existence, and the first in that of vegetables.

Some naturalists, however, have had an idea of discriminating between them by making the locomotive power essential to animals. But upon inquiry this character will not be found universally true ; for some species of these are found to adhere to rocks, without having the power of changing their situation.

Other naturalists have supposed, that the distinguishing character of a vegetable consists in its having neither brain, nor any receptacle answering to a stomach. It is true, we cannot discover any thing which bears an organic resemblance to the brain in any part of the vegetable body ; but, on the other hand, the ex-

istence of this organ cannot be demonstrated in *all* animals:—and with regard to the stomach, it is an organ of which some of these are also destitute; at least, it does not appear to exist as a separate and distinct apparatus, as in those animals whose structure and œconomy are more complicated. There are other organs the want of which in vegetables has also been considered as the discriminative mark between them and animals; but these distinctions, when critically examined, will appear equally vague and futile.

For the same purpose of characterizing animals and vegetables, different definitions have been had recourse to; but yet neither of them has answered the intention. Even that given by the

celebrated Linnæus is open to objections. With a view to discriminate the three departments of nature—he says, “*Lapides crescunt.—Vegetabilia crescunt et vivunt.—Animalia crescunt, vivunt, et sentiunt.*”

That part of this definition which relates to stones, if taken in its literal sense, is obviously inaccurate; for *growth* implies an expansion or evolution of parts consequent upon the action or functions of particular organs, which exist *only* in those bodies endued with the principle of life. But stones or fossils are inanimate substances, destitute of every kind of organization^a, and their magnitude

^a “ Their curious crystallization bears some resemblance to organization, but performs none of its functions; nor is any thing like the vital principle to be found in this department of nature.” *Vide* Smith’s Introduction to Botany.

is increased merely by the aggregation of matter, either by *mechanical* or *chemical* attraction, or perhaps by both. However, that "*Vegetables grow and live,*" will no doubt be admitted as incontrovertible truths; but we are not equally certain that they are destitute of every kind of sensation, though from the above definition it would appear that the absence of it in vegetables constitutes the most essential difference between them and animals. But even admitting the existence of such a difference, we should still be at a loss to know where nature has drawn the boundaries of each department; because this definition does not point out the means, or afford us any practical rule by which we are to ascertain the *existence* or *non-existence* of *sensation* in those beings which are accord-

ingly to be ranked in the class of animals or in that of vegetables.

From the great difficulty in drawing the line of separation between them, it is evident there must be some things in which they closely resemble each other ; and although the consideration of their analogies is not the immediate design of this essay, yet it will not be altogether foreign to its purport to take a general and summary view of these.

In the first place, it must be obvious even to the most superficial observer, that vegetables are endued with life ; and if we inquire into the physiology of the seed which originally gives existence to the plant, and mark its development and evolution, it will be manifest that the œconomy of generation in vegetables is regulated by the same laws as that in

10. GENERAL VIEW OF THE ANALOGIES

animals^b. These circumstances further show, that plants, like animals, have an internal organization and internal powers of growth ; and so very intimate is the analogy between the natures of these two orders of beings, that both are in many instances affected in the same manner by similar causes, and correspond in various other particulars^c. For instance, there are plants which, like animals, are *terrestrial*, some which are *aquatic*, others *amphibious*; and there is also a correspondence in the general physiology of these. Plants too, like animals, are more or less affected by change of climate and of seasons^d.

^b *Vide* Additional Observations—"On the General Analogies between Animals and Vegetables"—(2.)

^c *Vide* Additional Observations, *ibid.*—(1.)

^d "Apple-trees sent from hence to New England blossomed for a few years too early for that climate,

Both have the power of generating heat, but become languid under the influence of certain degrees of that element, and are also destroyed by too extreme a degree of cold. Different species of vegetables also require different soils, as different kinds of animals require different food for their nourishment and support*; and both become weak and sickly from a deficiency or the bad quality of it. The health of plants too, like that of animals, is impaired by an interrupted perspiration, and both die when deprived of air. In both, the seasons of propagating may be accelerated by the influence of heat, or retarded by cold. In both we find a

and bore no fruit, but afterwards learned to accommodate themselves to their new situation." *Vide* Botanic Garden, Part 2d, Canto 1st, Note on the Swallow.

* *Vide* Watson's Chemical Essays.

corresponding progressive duration of life ; and both are also subject to a variety of diseases, which in many instances shorten the natural course of their existence.

Even from this short view of the correspondencies between animals and vegetables, it is manifest that nature in the formation of each has acted upon the same general plan, and governs both by the same general laws : and although these circumstances may not be sufficient of themselves to prove the existence of sensation in plants, they are at least very presumptive evidences in favour of that opinion^f. But these analogies are

^f "Such organization evidently belongs not to inanimate matter ; and when we observe, in vegetables, that it is connected with, or instrumental to, the powers of growth, of self-preservation, of motion, and of seminal increase, we cannot hesitate to ascribe to them

not the only ground upon which it rests. Many other phænomena are observable in the vegetable œconomy, which seem further to show that the conjecture is not so far distant from probability as it might at first appear to be. Some of these phænomena relate to *motion* in vegetables, which although destitute of the *locomotive faculty*, yet are endowed with certain powers of motion, and many of them even to a much greater degree than some of the inferior orders of animals, several species of which are also destitute of *all* locomotive power. This is the case with sponges, sea-pens, and various other zoophytes, which being

a *living principle*. And by admitting this attribute we advance a step higher in the analogy we are pursuing: for the idea of life naturally implies perceptivity." *Vide* Manchester Mem. vol. ii. Dr. Percival on the "Perceptive Powers of Vegetables."

fixed by stems that take root in sand or the crevices of rocks, have no other power of motion than merely that of extending and contracting their bodies, or parts of them^s. But notwithstanding the power of motion is so very limited in these animals, yet it is adapted to their particular nature, and proportioned to all their necessities, and by an instinctive exertion of it they are enabled to protect themselves from various injuries, and to contribute to their own welfare and security. This observation is also applicable to vegetables ; for the power of motion of which they are capable, is no less appropriate to their particular nature, and is equally contributive to their well-

^s The power of motion in some species of shell-fish is also extremely limited, as in the oyster and many others with bivalve shells.

being. Hence, may it not be fairly inferred that they are likewise endued with *instinct*, and consequently with *sensation*?

But although nature may have bestowed on plants these attributes, yet, it does not necessarily follow that she has also made them capable of *voluntary* actions; for *volition* is a particular faculty of mind associated with other qualities, which render the being endued with them a rational agent^b. It is the *power* of *choice* exerted by the individual on particular occasions; and therefore, actions consequent upon the exertion of this power are more or less dependent on the *will*; but

^b "Volition is the actual exercise of the power the mind has to order the consideration of any idea, or the forbearing to consider it; or to prefer the motion of any part of the body to its rest, by directing any particular action, or its forbearance." (Locke on the *Human Understanding*.)

character, which not only denotes its species, but also in a great degree marks the nature of its abilities; and therefore, in comparing the attributes of the different orders of animals, we shall find, that whatever degree of intelligence may appear to be displayed by their actions, such actions always bear some relation to the particular organization of their frame. We cannot therefore make an animal perform any work of art which is not related more or less to its natural habits; or, in other words, we cannot endue it with instincts which are foreign to its œconomy, unless we could at the same time new-model the mechanism of its frame, and fit it accordingly for some new purposes^k.

The ingenuity displayed by the feathered tribe in the building of their

^k *Vide* Additional Observations on Instinct—(3.)

nests, and the art and address exhibited by the spider in the weaving of its web, cannot fail to call forth the admiration of the observer. But the skill which these and many other animals exhibit, cannot be applied, even by the most sagacious of them, to purposes beyond the sphere of their particular wants. These wants are similar in every animal of the same species, and each exerts itself like the other for the purpose of providing for them, without the aid of instruction or experience. Hence, although we perceive that some particular purpose is intended by the performance of many of the actions of vegetables, as well as by those of animals, yet, the intention is not in the agents themselves, but in that superintending Providence who has ordained their existence.

After these general observations, we are better prepared to consider some of those actions of vegetables which are founded upon their instinct: and a very familiar instance of motion in them, indicative of that attribute, is manifested by their universal aptitude to incline towards the light, which is so essentially necessary to their health and well-being. This disposition is so great, that a plant will even twist its stem and change the original direction of its branches and leaves in order to get towards it¹.

Some naturalists, however, ascribe these effects to the mechanical operation

¹ It is also a remarkable and very curious fact, that even "plants in a hot-house all present the fronts of their leaves to the light; and this influences even the posture of the branches to the side where there is most light, but neither to the quarter where most air is admitted nor to the flue in search of heat."—*Vide SMITH'S "Introduction to Botany."*

of light; but the evident benefit which a plant derives in consequence of those particular actions, as well as the circumstances attending these, render it most probable that they are the *spontaneous exertion* of that being to avoid what is prejudicial, and to obtain that which is more salutary, to its nature; thereby, like animals, contributing to its own welfare and preservation.

If this *self-inclination* of a plant towards the light were the effect of the mechanical action of that element, it is reasonable to suppose that a mechanical cause, operating on a plant so *powerfully* as to make it change the original direction of its branches and leaves, would necessarily act with more or less force: and as, moreover, that force is *continually* acting during the day, we

should also be led to expect, that like other mechanical stimuli *frequently repeated* or *long continued*, it would tend to exhaust, or at least to weaken, the living powers of a plant exposed to its influence, and that more particularly at a time when from a state of *debility* it is *less* capable of resisting the *exhausting* effects of exciting causes. But so far from occasioning any deleterious consequences, we find that *light* will very essentially contribute in bringing a plant from a *weak* and *languid* condition to a state of *health* and *vigour*.

Climbing plants also afford a curious instance of instinctive œconomy. Some of these having very slender stems cannot, like most other plants, grow of themselves in a perpendicular direction; but, in order to compensate for this incapacity,

nature has given them the power of moving or turning their branches and tendrils different ways, until they generally meet with a tree or some other body on which to climb or attach themselves, and when a tendril has laid hold of a support it coils up and draws the stem after it.

Trees and other vegetables have likewise the power of directing their roots for procuring nourishment ; and if this do not indicate an instinctive selection of food, it is at least something very analogous to it. For instance, a tree growing near a ditch will be found to direct its roots straight downward, on the side next the ditch, until they reach the ground below it, when they will throw off fibres underneath, and ramify like the root on the other side of the tree. Some curious examples of this kind of instinct are related by

Lord Kaimes, among which is the following: "A quantity of fine compost for flowers happened to be laid at the foot of a full-grown elm, where it lay neglected three or four years; when moved in order to be carried off, a network of elm fibres spread through the whole heap; and no fibres had before appeared at the surface of the ground."

Many flowers also fold up their leaves on the approach of rain or in cold cloudy weather, and unfold them again when cheered by the reanimating influence of the sun. This is remarkably exemplified in the *Convolvulus arvensis*, *Anagallis arvensis*, and many others, but more particularly in the last, whence it has been called the poor man's weather-glass. In Watson's Chymical Essays, also, it is stated that "*trefoil, wood-sorrel,*

mountain ebony, the *African marigold**, and many others, are so regular in folding up their leaves before rainy weather, that these motions have been considered as a kind of instinct similar to that of ants."

Aquatic plants also furnish some curious examples of spontaneous motion strongly characteristic of instinct. Among these, the *water-lily* affords a very remarkable instance, and that too connected with the reproduction of its species. This plant bears its flowers upon a foot-stalk under water, and when the flowering season arrives, the stalk rises perpendicularly without any regard to the stream, until the flowers reach above the surface of the water. At this time some of them expand, and then the antheræ discharge their fecundating dust upon

* This refers to the petals, not leaves, of *Calendula pluvialis*.

the stigma. About four o'clock in the afternoon the expanded flowers close, and the foot-stalk lies down either upon or under the water. It is erected every day until the flower has been fully impregnated, when it once more sinks under water, and there remains to ripen its seeds, which at a proper time escape from the fruit, and give birth to new individuals.

This is asserted by Linnæus and various other naturalists ; and, though controverted by some, has been recently confirmed by the observations of Dr. Smith, who authorizes me to use his name on this occasion. In cold or shady weather this phænomenon is less evident, and is explained by the writer last named as entirely owing to the stimulus of light. But yet, I presume, it is also in part referable to

instinct, and that light operates only as an auxiliary to that phenomenon.

Those particular operations of animals which appear directed to some useful end in their œconomy, we ascribe to *instinct*; and if any of the actions of vegetables are explainable upon that principle, surely, it cannot be inconsistent to ascribe to a similar cause those particular actions which they are observed to perform at the most important period of their existence. The propagating season of the different species of vegetables is not less uniform and regular in its returns than that of the different species of animals. At this period the animal obeys a particular impulse of nature, and the *inward* operation of that impulse stimulates the individual so influenced to the performance of those actions, which lead to the same conse-

quences as the phænomenon above mentioned. We know, moreover, that *light* is at all times a healthful and invigorating stimulus to the vegetable constitution ; and therefore, it is to be expected that the influence of such an agent will more sensibly operate on a plant at that particular season, and under those circumstances, which nature intends should be instrumental to the continuance of its species.

Besides the above examples of spontaneous motion in vegetables, there are other instances of it which take place on such particular occasions as strongly indicate the presence of sensation in this class of beings ; and if they are endowed with any degree of it, may we not very consistently suppose that they also capable of instinctive actions ? These instances of motion are observed

towards evening, and during the night, when plants are supposed to have also their season of *sleep*; and the external character of many of them appears so changed at this time, that it is often difficult to recognise their species. In some plants the leaves hang down by the side of the stem; in others, they rise and embrace it; and in some they are disposed in such a way as to conceal all the parts of fructification.

Motions of a similar kind also take place in the flowers. Some of these during the night fold themselves up in their calices; some only close their petals, while others incline their mouth or opening towards the ground. The mode of sleep varies, therefore, in different species of plants; and in consequence of this alteration of position in the flowers as

well as the leaves, the young and tender stems, buds, fruits, and the generative organs, are sheltered from the injurious effects of rain or dews, and the cold nocturnal air^m.

The propriety of applying the term *sleep*, to these phænomena, may, however, be disputed; and the occurrence of them ascribed to the absence of the stimulus of light. But although this may have some share in producing those effects, yet, it can only act as a partial cause, which indeed ope-

^m It is moreover a curious fact, recorded by Linnæus and other botanists, that the flowers cease to exhibit these phænomena after their impregnation is effected, or if their generative organs are removed before they have performed their destined office. The bountiful intention of nature in all this is very evident: for, as rain or dews would occasion the antheræ to burst before the plant arrives at maturity, the seeds would be

rates in a very similar manner on animals; for the absence of light is also favourable to *their sleep*, and this fact seems to point out further the analogy between *sleep* as strictly so called, and the effects which take place in plants, under the circumstances above mentioned.

However, leaving it to abler physiologists to decide on the propriety of the term, it is at all events very evident that an interval of rest is as necessary to the health and vigour of the vegetable as it is to that of the animal.

Many other examples of *instinctive*

rendered barren by the premature discharge of the fertilizing dust which the antheræ contain. But as there are plants which are always under water, nature has wisely adapted their œconomy to their situation, and those "aquatic vegetables which blossom under water seem to have a peculiar kind of glutinous pollen destined to perform its office in that situation." *Vide* Smith's Introduction to Botany.

and *spontaneous motion* in vegetables might be adduced ; but it is not necessary to particularize more in this place, as the instances already noticed are fully sufficient to show that plants have the power of *self-motion* ; and as they contribute thereby to their well-being, it is reasonable to conclude that they are, like animals, also capable of instinctive actions : and if *instinct* is the consequence or the necessary adjunct of sensation in *the one*, it is more than probable it is so likewise in *the other*.

Indeed it is supposed by Darwin that they even possess *voluntary* power ; and this he infers from their “ *being subject to sleep*.” He says, “ that as the *sleep of animals* consists in a *suspension of voluntary motion*,—and as *vegetables* are likewise *subject to sleep*,—there is reason to

conclude that the various actions of opening and closing their petals and foliage may be justly ascribed to a *voluntary* power; for, *without* the faculty of volition, *sleep* would not have been necessary to them^a."

The several phenomena which have been noticed on this curious subject, do certainly afford some ground for supposing that *sleep* is more or less necessary to the welfare of vegetables, as well as to that of animals. But although there is in this state a "*suspension of voluntary motion*," at least in those animals which are endued with this *power*, yet, it does not necessarily follow that *sleep* is a criterion of its existence, for *volition* is an attribute of *mind*, associated with a

^a Vide Darwin's Zoonomia; also, Botanic Garden
--Note on Chunda.

degree of rationality, which, in most animals^o, is compensated for by that *instinctive power* which I have before endeavoured to show is distinct from *volition*: I do not apprehend, therefore, that *sleep* is necessarily indicative of the existence of a *voluntary power*, although it may be so of a *sensitive* one.

In the Encyclopædia Britannica, under the article "MOTION^p," we are told that, "*were it not for the manifestation of sense by moving from one place to another, we should not be able to tell whether vegetables were possessed of sensation or not.*"

From this observation we are led to consider the power of locomotion as the

^o *Vide* Additional Observations "On Instinct"—(5.)

^p *Vide* Encyclopædia Britannica "Vegetable Motion" under this article.

chief criterion of sensation. But if it be admitted that every animal is endued with sensation in a greater or less degree, it is evident that the *locomotive faculty* is not a necessary adjunct of it; for some living beings are assigned to the class of animals which are *destitute* of the power of *locomotion*; consequently, the absence of this in vegetables cannot be urged as an argument against the existence of sensation in them.

It is further remarked in the same work under the article quoted above, that "*shell-fish, even those apparently the most sluggish and destitute of any apparatus for motion, are found to be furnished with such instruments as enable them to perform all those movements for which they have any occasion.*"

The truth of this observation cannot be disputed ; but it is equally applicable to vegetables : for, although they have not the power of going from place to place in search of food, or in avoidance of injury, yet, they are found to vary the direction of their roots according to the qualities of the soil. And, as they cannot avoid the attacks of animals by flight, they are furnished with various, and often very effectual means of defence, which will be more particularly noticed in another part of this essay.

Indeed, nature has endued every different species of living beings with such powers and qualities as are best adapted to that sphere of existence in which they are severally placed. In some animals we observe great powers of strength united with courage. In others we be-

hold the most wonderful agility and cunning; and those from which these particular qualities are withheld, nature has endued with others which are no less useful to the individuals possessed of them. It is obvious, therefore, that however different in degrees of usefulness and efficacy these various qualities may appear when abstractedly considered, yet, when relatively so, they will be found equally conducive to the same purpose in all; and that purpose embraces the *welfare*, the *preservation*, and the *continuance* of every different species of living beings, from man even down to the most lowly plant! Hence, if any of them be destitute of the locomotive power, it is because all the purposes for which this faculty is given to others are fully answered without it, and not required in their economy. Nor is

this a subject of mere conjecture; for we know, as already observed, that some animals are altogether destitute of this power, and in others it is so limited as to be scarcely discernible, as exemplified in the *flower-fish* or *Actinia*. The *progressive* motion of this creature is so very slow, that it has been compared to the motion of the hour hand of a clock; but although we may not be able to perceive the advantages the animal may derive from such a limited power of motion, yet, no doubt, it is as duly adapted to the purposes of its existence, as the more obvious intents of the actions of superior animals.

From this general view of *instinct*, *volition*, and the *locomotive power*, it would appear that they are distinct attributes, in as much as *instinct* may exist

independently of the other *two*, and the *locomotive power, independently* of *volition*. Indeed, if we attend to the particular character of the locomotive faculty in many animals, it is evident that the exertion of this power is merely instinctive, though it is not a necessary adjunct either of instinct or of sensation. But at the same time, I apprehend that sensation is necessarily associated with the instinctive faculty, although the former, like the latter, may exist independently both of volition and of the locomotive power; and perhaps we refuse to admit the existence of sensation in vegetables, under the idea that it is connected with the exercise of intellectual powers, which we cannot suppose to appertain to this class of beings.

SENSATION is a name given by phi-

losophers to those particular effects which are consequent upon impressions made on either of the senses ; hence, it has been defined, "*a perception in the mind excited by means of the organs of sense, independently of the will.*"

But the necessity of the existence of a *mental* power is hereby implied, and the *mind* is that which in man "*thinks, reasons, remembers, wills.*" If, therefore, the presence of such an attribute be necessary to the enjoyment of sensation, we may reasonably doubt the existence of this last in those beings which constitute the lower orders of animals. But even these, as well as the most sagacious brutes, are universally acknowledged to have sensation:—and yet, who will seriously contend that the latter are endued with all those mental attributes by which the "Almighty

Creator has so eminently distinguished man? We are not to divest of particular qualities any living being, because the definition which human imagination has framed, embraces more than what reason will allow us to suppose brute animals or vegetables can possess. If the former are acknowledged to have sensation, without at the same time possessing the eminent attributes of man, may not vegetables be endued with an inferior degree of sensitive power, as well as all other living beings?

If the intellectual faculties of man be compared with those even of the most sagacious brutes, the difference between the one and the other will appear much greater than between the actions of some of the lower orders of animals, and those

¹ *Vide* Additional Notes "On Sensation"—(1.)

of many of the vegetable tribe, exclusively, at least, of the locomotive power. And therefore, if we are to measure the degree of intellectual capacity in different animals by the extent or obvious usefulness of their particular actions, we might also ascribe some considerable share of this attribute to many of the vegetable creation. But *instinct* will be all-sufficient to account for their different actions as well as those of many animals; and where the instinctive principle exists, we are naturally led to consider sensation as its necessary adjunct.

There are, however; some naturalists who ascribe the motions of which vegetables are capable to *irritability*, a property which they say may exist in organized matter independently of sensation; and there are various circum-

stances which seem to favour this opinion. But I shall endeavour to show that none of these afford any conclusive evidence in support of the truth of it.

"IRRITABILITY" is generally defined "that *power* or *property* in living bodies by which parts are made to *act* or *contract* upon the application of a stimulus."

This definition, however, seems to imply only the existence of a *disposition* or *susceptibility* for action, as if that *power* were in a passive state until called forth into action by some *remote* exciting cause. But I apprehend that *irritability* is a particular power, which is *coëval* with the *living principle* itself of the individual, and *continually* operating in a greater or less degree, so long as the principle of life exists.

* *Vide* Additional Observations "On Irritability"—(2.)

* *Vide* Additional Observations "On Irritability"—(3.)

IRRITABILITY, therefore, may perhaps be more correctly defined,—

A particular *inherent power* or *property*, which is *continually* operating in a living body, and in consequence of which its *natural actions* may be *more* or *less* increased by some fresh exciting cause.

This definition may be also liable to some objection, though it is probably less so than the other. Indeed, it is in general very difficult to give in few words such a definition of any particular quality as shall be fully explanatory of the real nature of it. This is, however, the true intent of a definition; though what we often give as such, in reference to some particular animal attribute, is, for the most part, only a general statement of its effects, rather than what constitutes the

real nature or essence of it; and I apprehend that *irritability* comes within the sphere of this observation. *Irritability* is one thing, and its *effects* are another. I do not, therefore, presume to explain by definition the nature itself of that power, but only aim to state, generally, the effects depending upon its existence; and, whatever may constitute its real nature, I shall endeavour to show that the *irritability* of which plants are possessed is another, and very powerful, evidence of their sensation. Surely, it would be very inconsistent to suppose that a living being, so nearly allied to animals in organization, should be *destitute* of sensation, and yet at the *same* time susceptible of impressions.

It has been maintained, however, that the power of motion in vegetables is no

greater evidence of sensation, than are the contractions of the muscles of a limb on the application of a stimulus after its separation from the body.—But there is a very material difference; for, in the former case, the action is *continual*, and goes on independently of any *artificial* stimuli; while, in the other instance, the action is only *temporary*, and *excited* too by *mechanical* impulse.

But it has been also contended, that the principle of irritability in plants is not of the same nature as that in animals. If, however, we consider the particular effects depending upon the existence of this principle in the animal œconomy, and compare these effects with those which take place in vegetables, the correspondence will evidently show, that *irritability* is of the *same* nature, and

subject to the *same* laws in both. For instance, the *irritability* of plants, like that of animals, may be destroyed by similar causes; and in both it becomes diminished in proportion to the frequency of the application of stimuli, which, if too often applied, either on the same individual, or on the same particular part, will ultimately produce the effects of such as are more powerful, or more immediately destructive^t.

We must also bear in mind, that a plant is an organized and living being, and that without the presence of the living principle it would be inca-

^t It is observed by Darwin, that "the irritability of plants, like that of animals, appears liable to be increased or decreased by habit: for those trees or shrubs which are brought from a colder climate to a warmer, put out their leaves and blossom a fortnight sooner than the indigenous ones."—*Vide Zoonomia*.

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pable of motion, and of performing its various functions. It is the same with regard to an animal: if deprived of life, its different organs will cease to perform their office, and its power of motion will be also entirely destroyed: hence it is evident, that *irritability*, whether in the plant or the animal, cannot exist independently of life: therefore, if the principle of *irritability* is not of the same nature in both, then, it must necessarily follow that the *living principle* of the one is also *different* from that of the other. But this is an idea which would be inconsistent with philosophy and in opposition to her laws, which direct us, *not to ascribe similar effects to different causes.*

If, however, *sensation* be imputed to plants, it may with propriety be asked,

whether they are furnished with organs similar to those which are the seat of sensation in animals? Perhaps this would not be easily proved by ocular demonstration; nor indeed is it necessary that the *sentient* organs of *vegetables* should have the same structure, seeing that all those other parts which they are allowed to possess in common with animals, sensibly differ in their form and character; therefore, by analogy we may reasonably infer, that their instruments of sensation will have a corresponding difference^a.

Surely, it would be very presumptuous to insist that no other substance can perform the functions of nerves in other living beings, except what we may think pro-

^a *Vide* Additional Observations "On Sensation"—
(1) & (2.)

per to consider of the same nature as our own.—Upon this principle, we might call in question the muscularity of the flea, because its instruments of motion have not the usual character of muscular fibres; but, if these did not exist, how could we account for the wonderful feats of agility of which this little animal is capable? We might also with equal propriety contend that fishes are destitute of lungs, because their organs of respiration are different in structure, and even differently situated with regard to the other viscera, from the lungs of terrene animals. But we know that those particular organs to which we give the name of *gills* are to the fish; what the lungs are to the animal destined to live on land. It is therefore very obvious that different living beings are endued by Nature with particular

organs, which are the same, as to their use, in all, though more or less varied in their form, structure, and situation, according to the nature of the species and the mode of life for which they are severally destined.—Indeed, the existence of a nervous system in vegetables is rendered still more probable by the analogy between them and animals, in regard to those functions connected with their nourishment, and also on which their health and growth depend.

Whether a plant be nourished merely from the moisture it absorbs from the earth or air, or whether the soil where it grows afford matter still better adapted for its nutrition, yet, neither the one nor the other possesses any of the characters of the vegetable. The *bark*, the *wood*, the *leaves*, and the *fruit*, differ from each

other in their sensible properties, and the *root* is again different from all these ; but yet, each of these different parts and their peculiar qualities have been formed from the same original matter. Hence, as the nutritive substance, which has been taken up or absorbed by the plant, differs so widely from the vegetable machine itself, it is evident that plants, like animals, are furnished, not only with *assimilatory organs*, but also with organs of *secretion*, which, by their particular actions, form the variety of *tastes*, *smells*, and *properties* in different plants, and even in different parts of the same plant*.

* The various colours of plants are also supposed to depend upon some peculiar secretion; and of late years it has been discovered that some of them even secrete a stinky earth. *Vide* Smith's *Introd. to Botany*.

Perhaps it would be impossible to demonstrate the particular organs which are appropriated for these various purposes. But, we are not on that account to deny their existence. We should bear in mind, that, owing to the particular organization of some living bodies, we are often limited in our inquiries concerning the physiology of their systems. When, however, certain effects are produced, and these effects appear similar in their nature to those which evidently depend upon some peculiar structure of parts in beings more favourable to our researches, we are naturally led to infer, that such correspondent effects, wherever exhibited, will depend upon a correspondent organization.

Before the muscular structure of the *Uterus*, or of the *Iris*, was demonstrat-

ed, he would perhaps have been considered by many as a mere visionary in physiology, who had asserted the necessity of such a structure, only from the peculiar actions of these parts, and comparing such actions with those of other parts, the muscularity of which was more demonstrable.—But analogical evidence often leads to the discovery of very important truths, and therefore has claims on our attention, until we have better testimony to appeal to.

From the results of various experiments made upon some of the larger kinds of animals, we know that the influence of the nerves is indispensably necessary to the performance of many of their functions, and more particularly so of those which are connected with the important processes of *assimila-*

tion and of *secretion*. And no doubt this is also the case in regard to every animal, although there are some in which we cannot discover any thing that bears any resemblance to nerves^y. But, as sensation is not denied to exist in these animals, and as they must also necessarily perform those functions which in others evidently require the particular agency of these organs, it is obvious, that although we cannot discover their existence in every animal, yet, there is at least something in the organization of the one, corresponding to the nerves

^y The *tænia* or tape-worm is said to be destitute of nerves, but it is known to be very irritable, and perhaps the result of future inquiries will prove to demonstration, that it has a nervous system as well as other animals, of which, indeed, there cannot be any doubt from what we know of the animal œconomy in general.

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of the other ; hence it is evident that organs different from the general character of nerves *can*, and *do*, perform their functions in some animals ; consequently, it can be no very extravagant conjecture to entertain, that this analogy extends to vegetables, which, in so many other respects bear so near a similitude to animals in their physiology *. Indeed, this conjecture seems to derive additional support

* We know that the nerves vary more or less in structure even in the higher orders of animals, according to the functions of the part to which they are distributed, and this difference in structure will necessarily appear greater in those animals whose general organization is adapted to a different kind of existence.—Moreover, this difference will go on increasing, according to circumstances, until at last the nerves in some animals will lose all the characters they bear in others. We must therefore expect that the nerves or instruments of sensation in vegetables will have also a character peculiar to the organization and mode of existence of this class of beings.

from many curious circumstances relating to *irritability*.

It has been maintained by some very able physiologists that this power is derived from the nerves; and if so, as plants are *irritable*, and as the irritability appears to be of the same nature in them as in animals, may we not reasonably infer that they have also a nervous system, or at least something analogous to it, and consequently some kind of sensation*?

There are, however, other physiologists who contend that irritability is not derived from the nerves, and therefore may exist independently of all sensitive power^b. But I have endeavoured to show in another place, that if irritability do not entirely depend on these organs,

* *Vide* Additional Observations "On Sensation" (2.)

^b *Vide* Additional Observations "On Irritability" (1.)

yet they are the source from which it is chiefly derived^c.

It may however be further asked, *in what particular manner do vegetables feel themselves affected in consequence of any impression which they may receive?*

^c The following experiment made by Dr. HAIGHTON some years ago, when engaged in his experimental inquiry concerning what HALLER has called the "*Vis Insita*" of muscles, affords a considerable degree of support to this opinion.

Having previously traced with accuracy all the nerves distributed to the hind leg of a dog, he found that by cutting through the *sciatic nerve*, where it passes between the *tuberosity of the ischium* and *great trochanter*,—the *crural nerve*, soon after its passing from under *Poupart's ligament*,—and also the *obturator nerve*, immediately after its exit through the *foramen ovale ischii*, that *all nervous energy* was completely abstracted from the *gastrocnemius muscle* which was the subject of the experiment.

Immediately after the nerves were cut through, the muscle was exposed and stimulated with a pointed instrument, when it was observed to contract very forci-

Of this, I presume, it is impossible to form any idea, seeing that their sentient organs are necessarily so different from our own.—Indeed, this observation is also generally applicable to animals; for as the different species of them vary in their œconomy, it is probable that each

bly. But after waiting forty eight hours and stimulating the same part again, the irritability was so far exhausted that no action whatever could be excited. Even a *strong shock of electricity produced no visible effect*, though one of the same degree of strength occasioned a great deal of action in the corresponding muscle of the limb which was sound. However, after several days had elapsed, the muscle began to show fresh marks of irritability, and the animal gradually recovered the use of his limb. Now, if irritability were not derived from the nerves, why should not the muscle which was the subject of the above experiment have *continued* to obey the impulse of the stimulus, the same as the corresponding one of the other limb? And moreover, how could we account for the restoration of the power of action in the limb on which the experiment was made? *Vide Additional Observations "On Irritability"—(3.)*

may have sensations differing both in kind and degree from those of every other species, peculiar to their nature and adapted to their œconomy^d. But, although we may not be able to form any precise idea of the particular kind of pleasure or pain of which vegetables may be susceptible, yet we can easily determine which of the two sensations a plant may experience by observing its general appearance under particular circumstances.

HALLER calls that a *sensible part* of the human body when the mind may be made conscious of any impression made on it; and in brutes, he calls those parts *sensible*, which when stimulated occasion evident signs of uneasiness to the

^d Vide Additional Observations "On Sensation"—(2.)

animal. Now, the principles of this rule will very forcibly apply to vegetables. For instance,—if we do any injury to a plant, it will sooner or later, according to the degree and nature of that injury, exhibit such appearances as evidently show that it is affected by it. May we not, therefore, with equal propriety consider this as a mark of *sensitive* power; for, if the plant had been *destitute* of sensation, how could it have been, at the same time, subject to the effects of any injury; and these too, of a nature so different from what would have taken place if the plant had lost its vitality? —It would not be difficult to adduce many instances where the sensation of vegetables is manifested under such circumstances; but it will be sufficiently evinced by the following familiar fact. If we

take a healthy plant out of the earth, it will shortly after acquire a languid and sickly aspect, because it is deprived of that nourishment which is indispensably necessary to the continuance of those actions which are essential to its health and life.—But if the plant be replaced in the earth while it possess a certain degree of vigour, it will soon *feel* the salutary effects of this; revive, and flourish as well as before:—if on the contrary its living principle is extinguished, being *then no longer susceptible of impressions*, that very situation which before kept it in a healthy and flourishing condition will actually tend to hasten its putrefaction and decay.

When any particular analogies are discovered between different living beings, we cannot ascertain at once the utmost

extent of them, and therefore, we may be justified in the opinion that such analogies are combined with others, which future inquiry may render as evident as those already known. This observation is particularly applicable to the correspondencies between animals and vegetables; and under all the various phenomena which those correspondencies embrace, surely, it cannot be unreasonable to suppose that *all* living beings partake of sensation, of such kind, and in such degree, as is best suited to the particular sphere of existence in which Providence has placed them.

There are some philosophers, however, who contend that as plants are so much exposed to the depredations of animals and various other injuries, it would be derogatory from the goodness of the

Creator to endue the vegetable world with sensation. But, on the other hand, it may be asked whether the very same objection will not apply even with much greater force against the existence of it in animals?

Almost every species wages a perpetual war against the other, and in the very anticipation of this general strife, nature herself has furnished them severally with various means of offence and of defence.

Nay, there are many animals which war not only against individuals of a different species from themselves, but in many instances they carry on this system of hostility even among their own tribe. But will it be contended for a moment that even the most insignificant of these are destitute of sensitive power? I believe the reverse will rather be acknowledged,

and also that sensation is much greater in animals than in vegetables; consequently, their sufferings must be more severe when they are injured or destroyed. If, therefore, it derogate from the goodness of the Creator to endue the latter with sensation, it would seem far more cruel in him to bestow on animals a greater degree of it. Nay, such is the idea generally entertained of the bodily sufferings to which all animals are exposed, that, when we wish to inculcate sentiments of humanity towards the inferior creation, we often join to our precepts those touching lines of the immortal Shakespeare, who tells us, that even

“ ——— the poor beetle, that we tread upon,
In corporal sufferance finds a pang as great
As when a giant dies.”

But shall we dare impeach the Almighty,
of injustice or cruelty?

"Shall little haughty ignorance pronounce
His works unwise, of which the smallest part
Exceeds the narrow vision of her mind?"

If we contemplate only the evil, without considering the good which may arise from any particular institution of nature, it may seem irreconcilable with the idea of an all-merciful and benevolent Creator, to ascribe to him the appointment of that system which ordains the reciprocal destruction of so many individuals. But we are not to regard the laws of nature according to our partial view of their effects. We ought to consider the general tendency of those laws, and the purposes which they answer, before we pronounce them to be unjust or oppressive.

The hostility, which is observable among the different tribes of animals, has prevailed for a succession of ages, and tends to universal good. It appoints a particular boundary to the number of individuals in every species, which would otherwise multiply beyond all due proportion, and derange the whole "harmony of things." And therefore, however oppressively this system of general warfare may seem to operate towards some individuals, yet, it constitutes the very basis upon which is founded the order of the whole living creation, and is conducive to the happiness of every race of beings.

But why such a system should be necessary for the promotion of good, it is not in place here to inquire. The subject is a mystery, which will always

be the theme of wonder and admiration to the contemplative mind, but it will ever remain inaccessible to human understanding. Let us, therefore, in accordance with such conviction, rather observe a respectful silence, than arrogantly attempt to penetrate into the secret designs of Providence, or as vainly presume to account for things which are beyond the sphere of our comprehension.

We are not, however, to suppose that this carnage among the animal race is unlimited. If it were so, it would be equally subversive of that beautiful order which reigns through every department of nature; and therefore, although so many animals daily fall a sacrifice to one another, yet, in order to preserve a due balance of life in every species, we find that, besides the prære-

ative faculty with which they are severally endued, nature has also bestowed on their respective individuals some other particular power, or quality, by which they are protected, or protect themselves, from the attacks of many of their enemies, and thus preserve for a time their existence.

But it has been contended, that there are no such bounds to the destruction of vegetables; and this opinion is founded upon the idea, that they have not, like animals, the power of self-preservation; and this is also considered as another *moral* reason against the probability of the existence of sensation in plants.

In the Encyclopædia Britannica; under the article "ANIMAL," it is said that "*the principle of self-preservation is undoubtedly a consequence of sensation;*

and as it is never observed to take place in vegetables, we have a right to say, that the foundation of it, namely, sensation, belongs not to them."

This is unquestionably a negative inference, that plants would necessarily have sensation, if they were endued with the principle of self-preservation; and notwithstanding the observation quoted above, we find several instances of it mentioned in another part of the same work*. Indeed, this is a subject than which no other is better calculated to display the solicitude of nature to provide for the welfare and preservation of every living being, and the diversified means by which she can accomplish these important purposes.

* See article, "Natural History" — § "Vegetable Kingdom" § "Preservation," under that article.

We are not, however, to expect that the principle of self-preservation will be as strongly manifested in vegetables, as it is for the most part in animals, though in some of the lower orders of these it is not always very obviously marked.

On the subject of the *locomotive power*, an example was adduced where this faculty is so very limited, that the actions depending upon it are so obscure as to be scarcely discernible; and in another part of this Essay instances have been also alluded to, where the animal like the vegetable was even destitute of this faculty. But, in whatever degree or manner the power of motion may be possessed by any animal, we may venture to conclude that it is in every case consonant to its wants; and as we cannot reasonably ascribe any *will* or *motive* to

a being so low in the scale of animal existence, we must refer the exertion of that power to instinct^f.

This is, at least as I apprehend, the most rational point of view in which we can hold the subject; and when these actions, and the power on which they depend, are compared with the actions of many vegetable beings, we shall perhaps be more disposed to admit that plants are also endued with the principle of self-preservation. And the probability of this will appear still greater, when we consider that many of these *vegetable actions* are more discernible, and the advantage attendant on them even more evident, than those which are performed by many of the lower orders of animals.

^f Vide Additional Observations, "On Instinct"—(5.)

Several very familiar and remarkable instances of *vegetable instinct* have been noticed in a former part of this Essay; and independently of these, as well as various others which might be adduced, we find that a great variety of vegetables, like many animals, either by their structure, or some other particular means, are enabled to protect themselves from various injuries to which they are more or less exposed. There are plants and shrubs, that, like the porcupine, and the hedgehog, are furnished with thorns or spines which protect them against the attacks of many animals. Others have numerous prickly processes, which serve equally for defence; and as these and the former kind, in particular, afford very palatable food to many of the quadruped race, some effectual check is ne-

cessary to prevent an unlimited depredation among this class of vegetable beings^t.

Some other species of plants, like the wasp, are furnished with venomous stings, which often compel the quick retreat of the unwary assailants ; and although the

^t A very curious circumstance attends the large hol-
lies in Needwood forest. These trees are observed to have thorny leaves to the height of about eight feet from the ground ; but are smooth above, where they are beyond the reach of cattle.

It is also a very remarkable circumstance in the natural history of vegetables, that in some plants these weapons of defence disappear by culture ; in which respect they are compared to those animals which under a state of domestication lose their ferocity, and sometimes their horns. Linnæus calls this the taming of the plant. Those plants, however, which are furnished with prickles are not so liable to lose their instruments of defence as those which are furnished with spines. These last are an elongation from the wood, as in the common thorn, and the former arise from the bark, as in the moss-rose, &c.

wound which is inflicted by means of these instruments may occasion only a temporary inconvenience to some animals, yet, it may prove very fatal to others, particularly to the insect tribe. The sting is described by naturalists, as having at its base a little bag or reservoir for the poison, with an aperture at its extremity, through which it is discharged; and this contrivance is very similar to that of the venomous teeth of the adder, and the sting of the wasp.

The *Dionea Muscipula*, or Venus's Fly-trap,—the *Drosera*, or Sun-dew,—the *Dipsacus*, or Teasel, and various others, are likewise furnished with some particular contrivance for the purpose of preventing insects from plundering the plant of its honey or seeds.

Besides these curious mechanical, and

other contrivances, so wonderfully adapted for the protection of several species of plants, nature has had recourse to another expedient, which perhaps constitutes one of the most effectual and general means of defence among vegetables.

The various means which have been noticed belong only to certain kinds of plants; but there are none without some particular effluvia, which vary in power and quality in different species. In some they are very fragrant and agreeable, in others loathsome and often deleterious; and doubtless many plants are on this account either attractive or repulsive to those animals of which vegetables form a part or the whole of their food. A plant which is delicious and nutritive to one animal, may be very nauseous and even

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poisonous to others ; and, therefore, animals do not feed on every kind of vegetables indiscriminately, but only on such as nature has assigned for their particular use ; and these they instinctively select from an innumerable variety destined for the food of other species. Some of the reptile class are confined even to a single plant, are similar to it in colour, and are said to partake also of its medicinal qualities.

From this general view of the subject, it is evident that animals and vegetables reciprocally tend to the maintenance of a due balance of life through the whole creation ; and the particular manner in which this is accomplished, is one of those circumstances attending the institutions of nature, which cannot fail to convince us of the existence of a superintendent Providence. If there were not

a check to the destruction of living beings, as well as to their undue increase, some of the species would soon be exterminated ; and if there were a chasm formed in consequence of the extinction of even the most insignificant species, the whole system would be thrown into confusion, all order would be at an end ; and man himself would be at last incapable of resisting this seemingly trifling shock, and the whole living creation would soon be annihilated.

“ ————— each moss,
Each shell, each crawling insect holds a rank
Important in the plan of Him who fram'd
This scale of beings ; holds a rank, which lost
Would break the chain, and leave behind a gap
Which nature's self would rue.” —————

We must also bear in mind, that although the means of defence which nature has given to animals and vegetables, may not prove always effectual for their

individual preservation ; yet, millions of them go through the natural course of their existence, without having suffered from the depredations of their enemies. And even those individuals, which fall a sacrifice to the wants or the appetites of others, have for the most part enjoyed that portion of existence allotted to them, and experienced every degree of happiness of which their nature is capable.

The microscope has discovered to us an innumerable multitude of beings, of whose existence we had no idea before ; and though legions of these are daily devoured by the innumerable tribes of other animals that feed on the vegetables or fluids where these diminutive creatures abound ; yet, can we reasonably imagine that such a profusion of living beings exists without enjoyment ? Or, shall we

suppose that sensation has been bestowed on them merely to swell the catalogue of sufferings, and multiply the sum of misery in the animal world?—Such an idea is as revolting to reason, as it is incompatible with the infinite goodness of “NATURE’S GOD.” We may, therefore, confidently believe that these diminutive beings have their season of enjoyment, as well as the enormous leviathan, although perhaps only a few hours encircle the whole course of their appointed existence!

How infinite then is that POWER who could organize such an atom of matter, and give it life and motion!—and, how transcendent in goodness, to endue it also with the means of enjoying its existence! And surely, that Being by whom such things can be effected, can likewise bestow on vegetables a capacity

to enjoy their own state of life ; and by which, too, the sum of happiness in the universe will be abundantly multiplied !

The lot of every race of beings inferior to man would, indeed, be very deplorable, if, like him, they were endued with reason, and capable of contemplating their subordinate condition, which exposes them to so many evils. But Providence has benevolently concealed this from their knowledge, and they enjoy their existence without reflecting on its state :

“ The lamb thy riot dooms to bleed to-day,
Had he thy reason would he skip and play ?
Pleased to the last, he crops the flow'ry food,
And licks the hand just raised to shed his blood.”

Life, therefore, has its due measure of enjoyment for all, according to the nature of the beings endued with it. Hence, so

far from militating against the goodness of the CREATOR in having endued the vegetable world with sensation, the idea of it exalts our conceptions of the power and beneficence of that OMNISCIENT BEING, who is so

“ Merciful over all his works, with good
Still overcoming evil.”

Man, as a rational agent, is most eminently distinguished from all the other tenants of this world^b, but, the existence of all those various beings which rank below him, is equally important in the grand design of creation. And, as we are incapable of ascertaining where Nature may have drawn the line of separation between the animal and the vegetable worlds; it is possible that some of those beings, which, at present, are supposed

^b *Vide* Additional Observations “ *On Instinct*”—(4.)

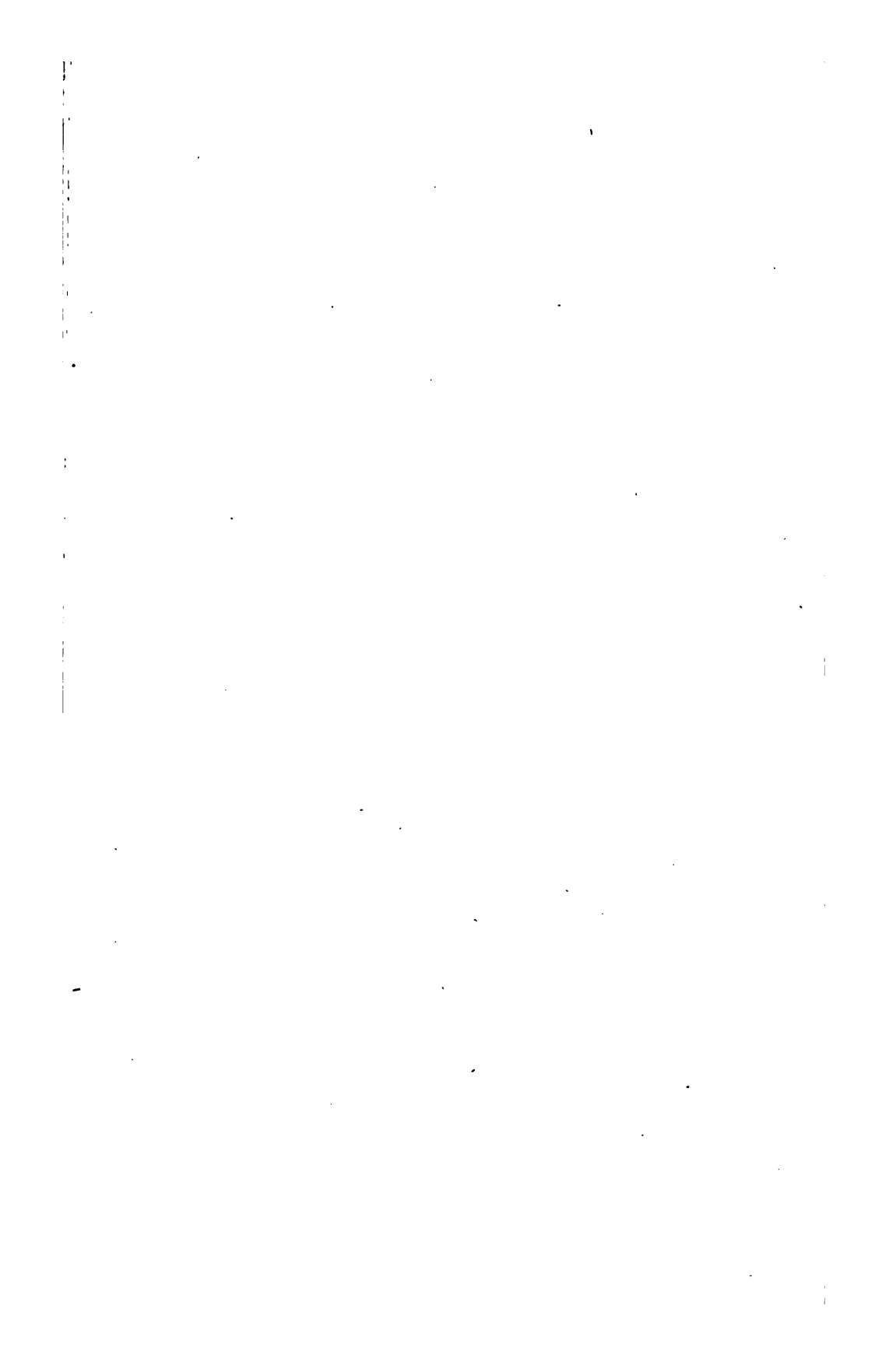
to be of a vegetable nature, actually belong to the class of animals ; while on the other hand, some of those individuals which are considered as belonging to this, in reality appertain to the other. Hence, if we deny the existence of sensation in all those beings which naturalists have assigned to the class of vegetables, we may be, at the same time, denying the existence of it in many animals. But every individual which is considered as belonging to the animal world is universally acknowledged to have sensation, whatever be its form, or the mode of its existence.

In the early part of this Essay, a general view was taken of the analogies between animals and vegetables ; and the phænomena which those analogies embrace will, at least, induce us to pause,

before we pronounce that the vegetable world is excluded from all sensation. If, however, we are to form our conclusions on the subject according to the general principles which govern our decisions in other cases of analogy ; we shall be led to infer that vegetables, like animals, are endued with sensation, of such kind, and in such degree, as is best adapted to their own sphere of existence¹. But yet, this is a subject which does not seem to admit of any positive conclusion ; and perhaps no ingenuity however great, nor industry however diligent and persevering, will ever enable us to gain the summit of those difficulties which seem to conceal from our view the real truth. Impressed with this idea, and feeling my own inability for the task, I offer the

¹ *Vide* Additional Observations " *On Sensation*"—(1.)

above speculations with diffidence ; and if any thing have been advanced worthy the attention of the reader, or which may have beguiled an idle hour, my intention will be answered, and I shall congratulate myself on having been so happily successful.



ADDITIONAL OBSERVATIONS

ON

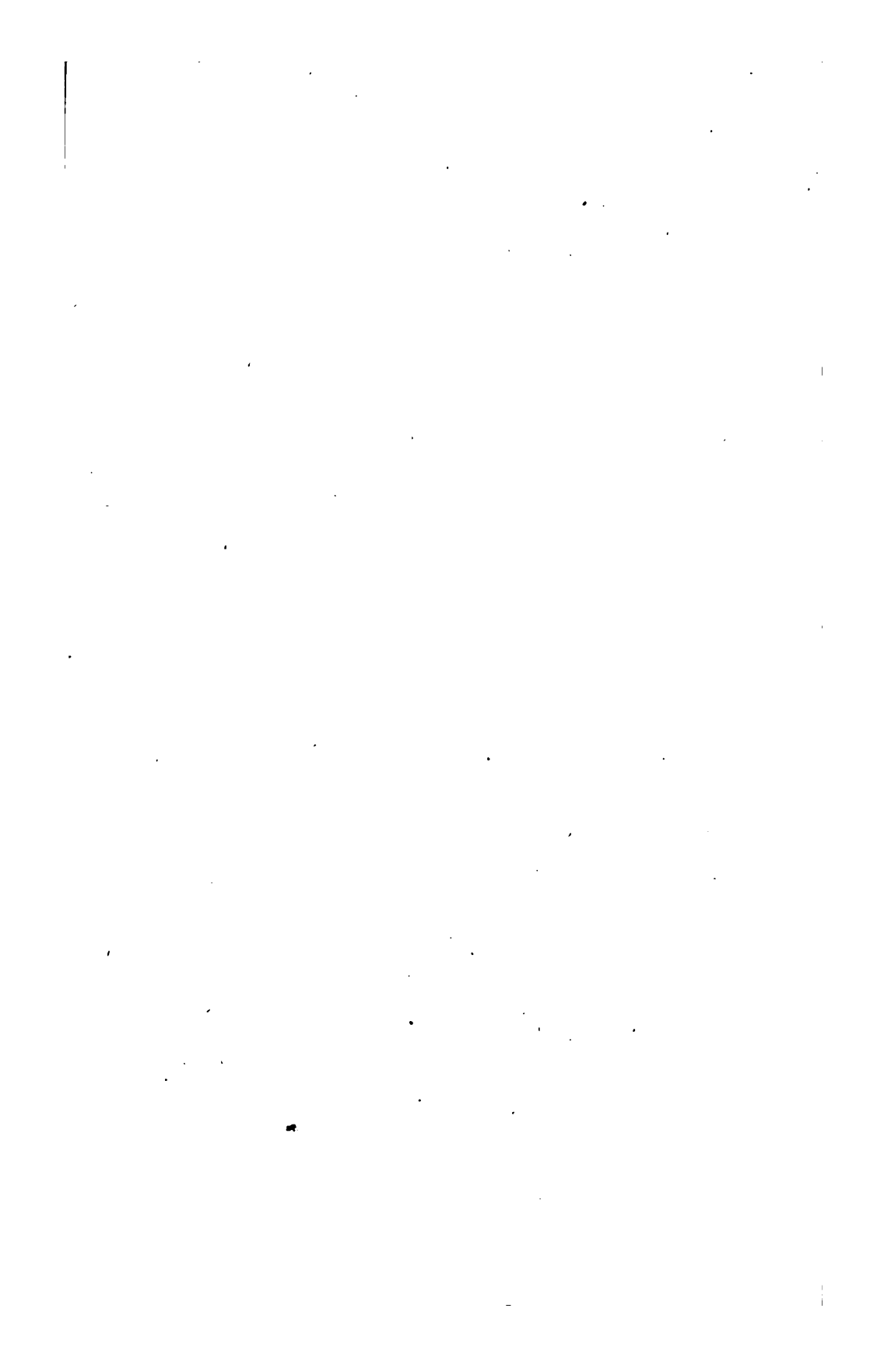
THE GENERAL ANALOGIES

BETWEEN

ANIMALS AND VEGETABLES;

ALSO ON

INSTINCT, SENSATION, AND IRRITABILITY.



OF
THE GENERAL ANALOGIES

BETWEEN

ANIMALS AND VEGETABLES.

(Continued.)

(1.) **I**N whatever way we view the animal and the vegetable creation, so many analogies are observable between the one and the other, that they seem to constitute only one chain of living beings, of which the different species belonging to each department form the different links.

From the gigantic elephant to the most minute animalcule, and from the stately palm to the most humble moss, there is a correspondent regular gradation, and correspondent difference in the size and the or-

ganization of the different beings belonging to each class; and each gradation embraces a multiplicity of species, which at a particular period of their existence are enabled to perpetuate their kinds.

The season of maturity, as well as the mode in which propagation is accomplished, necessarily varies in many different species. But these different modes, like the various organizations, are also only necessary modifications of one original plan, corresponding with the different œconomy of the several kinds of animals and vegetables.

Animals have been divided by naturalists into the *viviparous* and the *oviparous*; and although plants are for the most part propagated by seed, yet, as they are not all confined to that mode of propagation, they have been also divided into the *oviparous* and the *viviparous*. Those plants which are propagated by seed are included in the first division, and those which may be propagated by buds and bulbs are usually comprehended in the latter, and in this are included trees and

shrubs, but more especially bulbous-rooted plants^a.

There are plants which are also propagated by suckers, slips, and cuttings, and in these various modes, the polypus holds up the analogy in the animal department.

Another striking point of coincidence in the œconomy of generation between animals and vegetables, relates to the production of *mule* individuals. We know that two animals of a different species will, if they propagate, produce a mule; so likewise, *hybrid* or *mule plants* are sometimes produced, by fœcundating the female flowers of one

* Buds arise either from the stems or branches. If separated at a proper time from the parent vegetable and placed in a fit situation, they will grow and become perfect individuals capable of propagating their species. The analogy between the propagation of the viviparous animal and that of the vegetable is still greater in bulbous-rooted plants. The *fœtal* plant is inclosed in the centre of the root, like the *fœtus in utero*. In due time the plant makes its way through the coats of the root, and gradually grows until it flowers. It then ripens its seeds and dies, and a new plant is again formed from the old root.

species with the *pollen* of another. But in neither case can such individuals, in general, reproduce their kind.

All these circumstances demonstrate how very nearly animals and vegetables correspond in the œconomy of their generation; and these particular analogies have been introduced in this place, in order to afford some ground upon which to offer a few observations on the probable manner in which the *seed* is rendered fertile.

(2.) A variety of conjectures have been formed on this subject; but perhaps these differences of opinion have been in a great degree owing to the disputes which have arisen concerning the generation of animals. It is not necessary, however, to enter into a detail of all these various theories. This would lead to a discussion far beyond the intended limits of these observations; and it will be sufficient for the present purpose to notice the opinion which, I believe, has been most generally received by naturalists,

and then I shall offer an idea on the subject, founded on some experiments of Dr. Haighton concerning animal generation^b.

It is well known that, at a particular period of the flowering season of the plant, the *antheræ* discharge their *farina* upon the *stigma*; and it has been supposed that the particles of this fine powder burst, and emit a very subtile matter, which, being absorbed by the style, is conveyed down to the rudiments of the seed, which is thus rendered fertile. I apprehend, however, that this idea owes its existence to what has been conjectured with regard to the animals; namely, that the *fœcundating fluid* stimulates the *ovaries* by its being applied to their surface by the *Fallopian tubes*. But from the experiments alluded to, of Dr. Haighton, it would seem that the appearances observable in the *ova*-

^b The reader may see an account of these experiments in the Philosophical Transactions for 1797. They were made at the time the author was a pupil of Dr. Haighton, who kindly afforded him the opportunity of witnessing them.

ries, referable to impregnation, are to be considered as *sympathetical effects*.

I do not know that the generative organs of plants will admit of any analogous experiments; but yet, as vegetables resemble animals so closely in their general œconomy and other parts of their physiology, we may reasonably infer that the impregnation of the plant is effected upon similar principles. Hence I apprehend that the *pollen* acts first as a stimulus on the *stigmata*, the effect of which being *sympathetically* communicated to the *germen*, imparts to the *seeds* that principle upon which their future evolutions and propagating powers depend.

OF INSTINCT.

(Continued.)

(1.) **MAN** is endued by nature with the greatest number of instincts ; and although marks of them all are more or less observable in the brute creation, yet, we do not find any of them in which the whole of these are combined. Nor are the instincts which Nature has assigned to any particular species, capable of all those various modifications of which they are susceptible in the human race. They are, however, in every way adapted to the respective necessities of the several species; and such is the particular character of this wonderful attribute, that, perhaps, it is impossible to distinguish upon every occasion, between those actions which are absolutely *volitive*, and those which are solely *instinctive*. But, there must be a difference, although we may not be able to perceive the line of distinction.

Indeed, some *instincts* possess so much of

the external character of reason and intelligence, that many animals seem to indicate by several of their actions, the exercise of *reflection*, even to a considerable extent. Many of our domestic animals afford instances of this kind. The hen, which has been robbed of her eggs, will leave her present situation, and go to another place where she will lay the remainder. Also, the hen-turkey, by a particular noise strongly expressive of anxiety and distress, will warn its young brood of threatening danger: and the cat will often display the greatest care and artifice, in concealing her kittens.

The deer kind, likewise, will elude the pursuit of the dogs or of the huntsmen with extraordinary address and cunning; and these qualities are no less conspicuous in the timid hare.

Many other examples of a similar nature will, no doubt, occur to the mind of the reader. It may, however, be questioned whether such actions are absolutely the result of a *deliberating and reflecting mind*? Either,

they are, or are not; but if we look to all the attendant circumstances, I apprehend that we shall be more disposed to ascribe them to instinct. In some of the above examples, a particular order of actions is undertaken by the parent animal for the *protection of its young*:—in the other instances, the active powers are exerted for *self-preservation*; and the principles on which these actions depend, constitute the basis of the two first laws of nature, and give rise to the most powerful instincts in all animals. It is therefore to be expected that the performance of actions which are connected with such important circumstances, will bear a very close resemblance to those particular exertions which are the result of intelligence and design in *rational* beings.

If we descend to the insect tribe, we shall also find that the instinctive operations of many of them seem to be as strongly characteristic of reason, as any of those of the most sagacious brutes. What sagacity, and what geometrical skill appear displayed in

the construction of the cells of the honey-bee, and how wonderful the result of its diligent toils !

“ There Machiavel in the reflecting glass
May read himself a fool. The chemist there
May with astonishment invidious view
His toils outdone by each plebeian bee,
Who, at the royal mandate, on the wing
From various herbs, and from discordant flowers,
A perfect harmony of sweets compounds.”

The industrious ant appears to show no less sagacity in providing for its future wants:

“ ——— to the field she hies, and on her back,
Burthen immense! she bears the cumb'rous corn ;
Then many a weary step, and many a strain,
And many a grievous groan subdued ; at length,
Up the huge hill she hardly heaves it home :
Nor rests she here her providence ; but nips.
With subtle tooth the grain, lest from her garner,
In mischievous fertility, it steal,
And back to daylight vegetate its way.”

How wonderful, too, are the instincts of the moth and the butterfly ! These animals have particular kinds of substances assigned by nature for their food, which varies

according to the species, and the different states of existence through which they have to pass before the final purpose of their creation be answered. When arrived at maturity, their instinct prompts them to deposit their eggs in those particular situations, where the young caterpillar will find its appropriate food as soon as it escapes from the egg, although the matter which is to afford it nourishment, does not form any part of that of the parent-animal in its present stage of existence. This circumstance seems to indicate great powers of discrimination, as well as foresight; but if the several operations of these and other animals depend on the exercise of so much judgement, we must, indeed, admit that they are endued with *rational* faculties; and that too, in a degree, which would leave even the *lord of the creation* far behind in intellectual power. But we shall find him still pre eminent in reason, and deriving from this source advantages, which the other tenants of this world never can enjoy.

(2.) The instincts of animals necessarily vary, both in their nature and extent, according to the œconomy, or the exigencies of the species; and, from the similarity, in the external characters, between many *intellectual* and *instinctive* operations, we often ascribe to animals powers of a nature which, perhaps, do not absolutely appertain to them.

With all the seeming sagacity alluded to, of the hen, she will mistake a piece of chalk, or of marble, for an egg; and she is also incapable of distinguishing between her own and those of another species. She will even sit upon eggs which she has laid, although they have not received that stimulus which is indispensably necessary to render them prolific*. Now, if the animal were guided by any *reasoning* power of *her own*, why should she manifest so much sagacity in one instance, and betray so much stupidity in another; and that too, in what relates to the very same part of her œconomy? It is reason-

* *Vide* a very interesting chapter on Instincts, in PALEY'S "NATURAL THEOLOGY."

able to infer that in the former instance the animal is guided by some impulse which supplies the place of reason, and that impulse prompts it to the performance of those particular actions which seem to be directed by an *intelligent* and *provident* mind. Hence it is evident, that every appearance of rationality in the brute creation, is not an infallible criterion of its presence; and if we have any cause to doubt the agency of that attribute in some animals, which under particular circumstances may seem to be endued with it, we are justified in doubting the presence of it in other beings, although we may not have the opportunity of observing them in those situations in which they might confirm the truth of this conjecture,

(3.) Instincts are not only different in different species of animals, but they are also in some respects different in the same individual, at different periods of its existence. On this account, an animal will often appear to accommodate itself to particular

situations, as if guided by reason; and on various occasions, as if it were also endued with a *voluntary* power of imitating the works of art of its fellow-species. But neither of these circumstances is necessarily characteristic of the presence of a *rational* mind, nor, consequently, an evidence of the exercise of such an attribute in the correspondent operations which are observable among animals of the same species.

If this accommodation to particular circumstances, or these correspondent operations were to be considered as sure indications of the presence of a *rational mind*, the *rationality* of vegetables might be contended for on similar grounds; for, they have also the power of accommodating themselves to new situations.^d; and in their instincts, the same species likewise show a correspondency of actions, the nature of which, is in many instances very remarkable. But who will seriously contend for the existence of a *rational* power in vegetables?

^d *Vide* note ^d, page 10.

If the same animal could acquire the talents of any particular species, by labouring purposely for that end, and exert such talents, either for pleasure or convenience, or from necessity, as occasion might require; this would indisputably evince the presence of a *rational* mind, and the correspondencies observable in the works of animals might then be ascribed to a *purposed imitation*. But it requires the exertion of a considerable share of *rational* power to imitate any work of art, with the view and intention for so doing. Such *imitable* performances are the result of a series of *voluntary* exertions, *purposely* directed to a particular object, the like to which, the *mind* contemplates to execute; and that very contemplation is an act in which the *discursive power* is necessarily called forth. But can we reasonably suppose that every animal is guided by such a faculty when only exerting its talents for the purpose of providing for its particular necessities? That exertion is merely an *in-*

stinctive one, consequently, the *discursive* power would be both superfluous and unnecessary on such an occasion. Shall we not, therefore, with greater propriety ascribe the various powers of the several species to a physical cause, connected with a particular organization, which is *providentially* adapted to the various destinations of each*?

Every species has its particular wants; and nature has endued them, severally, with such abilities as are best adapted to provide for those wants,—but the same degree of skill cannot be applied by any animal to other purposes; nor has it the power of varying the manner of its operations according to the dictates of a particular fancy. Every individual of the same species exerts its abilities in the same manner, without the aid of instruction or experience. The first time that the beaver erects its curious habitation, the bird builds its nest, the honey-

* *Vide* PALEY'S "NATURAL THEOLOGY,"—on "Particular Organizations."

bee constructs its cell, or the spider weaves its web,—the whole is executed with the same dexterity and skill as at any future period. The instinct of an animal is the source of all its talents; and that instinct determines the particular purposes to which only, those talents can be applied, and the extent to which they can be of any avail.

The dog, which on so many occasions displays such marks of sagacity, could never be taught to imitate the curious architecture of the beaver; nor could the beaver, with all its ingenuity, build a bird's nest, although the materials for the purpose, and a model for imitation, were placed before it. These observations are equally applicable to the insect tribe. The ingenious and industrious honey-bee would be alike incapable of forming any thing like the web of the spider; and we should as vainly expect the spider to be taught to assist the bee in building its cells, or to construct any thing which had the most distant resemblance to them.

(4.) Whatever degree of *rational* power, therefore, may appear to guide any of the brute creation, it is evidently distinguished by a certain character, and marked by particular boundaries in every species, according to the nature and destination of each. But man may employ his intellectual faculties to purposes, which in variety and extent are almost infinite; and for this power, perhaps, he is chiefly, if not altogether, indebted to the superior excellence of that attribute of mind to which we give the name of *memory*; for, in proportion as that faculty is weak, his mental attainments seem to be more or less limited.

It does not form a necessary part of the present subject of discussion, to inquire into the *nature itself* of *memory*. But whatever may constitute *that* nature, there are some very important points of difference between this attribute in the human species, and that, with which some of the brute creation are endued. In the latter, memory is the same,

both in kind and degree, in the different individuals of the same species; and, like their instincts, bears a relation to their particular economy. But in the human race, this attribute varies in excellence in different individuals, even under similar circumstances; and it is likewise dependent on the *will*; so much so, that we are sometimes enabled to suppress the remembrance of some particular things, by *purposely* directing our thoughts to other subjects. Or, in other words, by recalling particular ideas which will occupy the place of those which it is our object to remove or banish from the mind. This, however, may be a very difficult task to accomplish on particular occasions; but yet, as the thing is practicable, it is evident that *memory* must be in some degree dependent on the *will*; and this is another very important circumstance in which this attribute differs from that in brute animals^f; for we have no reason to sup-

^f *Vide* the subsequent note.

pose that they have a similar power of directing their thoughts to, or from, any particular subject, the remembrance of which may give them either pleasure or pain⁵.

These observations may perhaps be considered as digressive; but there are various circumstances connected with *instinct*, which seem to be very nearly allied to those which more immediately relate to *memory*. I shall therefore offer a few more remarks which will probably afford some degree of support to what has been already advanced on the subject.

Metaphysicians have divided *memory* into *two* kinds; the *passive*, and the *active*. The former, is when we remember any thing without any effort of the mind; and the latter, when we recover to memory any circumstance which does not occur to the mind without some exertion of its powers: the one, therefore, is called *remembrance*; the other, *recollection*; and this distinction will assist us in the inquiry, how far memory as a *passive* attribute is sufficient to account for some of those actions, which in many brute animals seem to depend on that exertion of mind which is necessary to constitute those actions *actions of recollection*.

In our ordinary pursuits, we often experience in ourselves the effects which this *passive* attribute is capable of producing. In these pursuits, we often meet with circumstances which will accidentally operate as exciting

(5.) It cannot, however, be disputed that the actions of some of the higher orders of animals cannot be satisfactorily explained, solely, upon the principle of instinct. But,

causes on the springs of memory, and *spontaneously* bring back to the mind the idea of particular things, which otherwise might never have occurred to it again.

This *spontaneous* remembrance may arise, not only in consequence of the accidental re-operation of former impressions, but also by the removal or absence of some impressing cause, to the effects of which we have become so familiarized as to be no longer sensible of these during the accustomed operation of that cause which first gave rise to them. When any particular sensation is thus worn away, the removal of the cause which first occasioned it, will, as it were, place us in a new situation with respect to some external circumstances, and *indirectly* occasion such *corporeal* or *mental* sensations as will produce such effects, or lead to such actions, as in their external character will appear similar to those, which are consequent upon *positive* impressions. This is experienced on various occasions, and the fact affords a further illustration of the possible and extensive operation of memory, where it may exist only as a *passive* attribute.

In this way, either *direct* or *negative* impressions on the external senses of brutes, may so operate on their

although some of them may be endued with a degree of *rational power*, yet it is to a very limited extent; and as we descend in the scale of animal beings, we shall find that even this limited degree of *rationality* becomes gradually weaker; while, on the other hand, the *instinctive faculty* manifests itself more and more until it becomes the *sole* principle of action, and unerringly prompts the animal to the pursuit of that which is most conducive to its welfare. In this pursuit it will often appear to accommodate itself to particular circumstances, as from design; but this is no more the result of design on the part of the agent, than the *first* action of sucking of the new-born

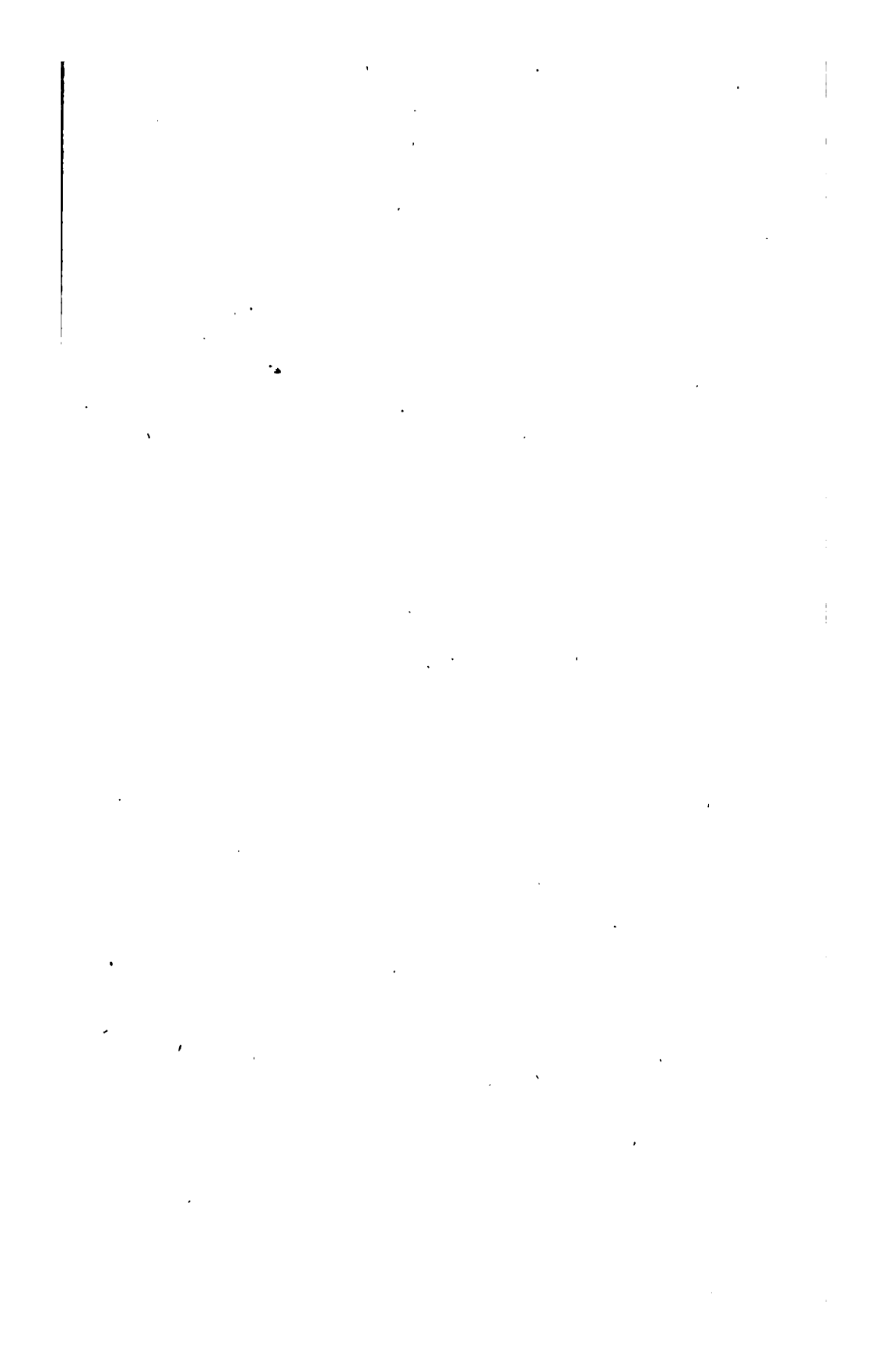
mental faculties, as to lead to the performance of actions relating to past events; and although those actions may seem to depend on some *mental* exertion connected with memory, yet, they may be independent of all such exertion. It is probable, therefore, that the memory of brutes is for the most part, if not altogether, *passive*: but in the human species it is either *passive*, or *active*, according to circumstances.

viviparous animal. Its instincts determine its actions, and for which its organization is duly and most admirably adapted by the hand of an inimitable artist^h.

From this view of the subject, we may form some idea how far instincts may supply any deficiency of intellectual power, and even compensate for the total want of reason in the brute creation. But where shall we find any power, or quality, as a substitute for sensation? The idea of *instinct* is naturally associated with that of *life*, and the idea of both, either jointly, or separately, with that of *sensation*; and as sensation does exist in animals independently of those eminent attributes with which it is combined in our natures as rational agents, may we not reasonably infer that vegetables have likewise their share of sensitive power, and consequently the means of enjoying their own existenceⁱ?

^h Vide PALEY'S "NATURAL THEOLOGY,"—"Prospective Contrivances," and—"Pe:uliar Organizations."

ⁱ Vide Additional Observations—"On Sensation."



OF SENSATION.

(Continued.)

(1.) **THE** Almighty Creator has bestowed on the various species of animals such attributes as are best adapted to answer the intents for which they were, severally, called into existence; and as **HE** has likewise endued vegetables with life, for purposes equally important in the general plan of Creation, no doubt that they, in common with animals, also enjoy their existence in that particular sphere which they occupy in the universe.

Many of the brute creation, in common with man, are furnished with particular sets of organs, each of which is differently adapted to receive impressions of external things; and through the medium of those organs, these animals, like ourselves, are endued

with the sense of *sight*, of *smell*, of *hearing*, of *taste*, and of *feeling*. By this last, however, is meant only that *sensitive* property on which depend those various sensations we experience when any part of the body is made to come in contact with some other part of itself, or any other kind of matter. This *sensitive* property exists in every part of the body, in a greater or less degree; and those organs which furnish the other senses, partake of it in common with the other parts. But these parts have not at the same time that organization which is adapted to create those sensations, which, according to their nature, we refer either to the sense of sight, smell, hearing, or taste. Such a general distribution of all the senses would give rise to such confused sensations, as would be productive of the greatest inconvenience. Each of these senses, therefore, depends on a particular organ of exquisite and singular structure; and if its functions be destroyed, there is not in the whole of the animal œconomy any apparatus which

can supply the loss of it: hence, we cannot see through the medium of any other organ than the eye; nor smell, nor hear, nor taste, by means of any other organs than those which are appropriated for these particular purposes.

It is not necessary, however, that every species of animals should be furnished with all these senses, in order to constitute the individuals of it perfect beings of their kind. As we descend in the scale of animal existence, we find that the species become less elaborate in their internal structure, and that they possess a fewer number of organs as organs of sense, and as instruments of action. But still their organization is duly adapted to all the circumstances in which they are placed. An animal, therefore, of the most simple structure, is in its nature as perfect as one of the most complicate and elaborate organization; and whatever difference may appear either in the size, structure, or mode of existence, of any particular kind, yet the sensitive power is

ascribed to all. Hence, as vegetables are also endued with the principle of life, and organized according to the nature of their existence; and as, moreover, that principle is the same in the vegetable as in the animal, it is reasonable to infer, that if life be associated with sensation in the one, it is so, likewise, in the other^k.

(2.) An animal may see, smell, hear, taste, and feel; but the enjoyment of these senses, either collectively or separately, is not necessarily connected with the presence of a rational mind; nor is a rational mind indispensably necessary to the enjoyment of life. If we contend to the contrary, then we must deny the existence of sensation to a multitude of animals, or ascribe even to the very lowest order of them an intelligent power. But this is a doctrine which, I apprehend, no one will seriously support; and therefore, if even the most insignificant animal enjoy its humble existence, although it

^k *Vide* page 48.

is destitute of a rational soul, may we not, under all circumstances, reasonably infer that vegetables do the same? Nor will the truth of this conjecture be disputed on the ground that we cannot form any idea of the particular manner in which they may feel affected either by pleasurable or painful impressions, for, we are also unacquainted with the sensations which the brute creation experience.

When we speak of a living animal, we naturally associate the idea of sensation with that of its existence; but this does not, at the same time, give us any notion of the particular nature of the pleasure or pain of which the animal is susceptible. The same impressions will create very different sensations in animals of different species; and this difference will probably be still greater between those animals which inhabit different elements. Some of each class are furnished with similar organs of sense, which organs appear to be constructed on the same plan in the individuals of each ele-

ment; but yet, we shall find a peculiarity of structure adapted to the œconomy of the species; and that peculiarity of structure, as well as the different nature of the element in which they exist, must consequently occasion a difference in their respective sensations. Hence, as vegetables are necessarily so different from animals in their mode of existence, it is very evident, that we cannot form any idea how they feel affected under any circumstances; but we are not on this account to conclude that they are destitute of every kind of sensation. “As they possess *life, irritability, and motion*, spontaneously directing their organs to what is natural and beneficial to them, and flourishing according to their success in satisfying their wants,—may not the exercise of their vital functions be attended with some degree of sensation, however low, and some consequent share of happiness ‘?’”

¹ *Vide* SMITH'S “Introduction to Botany.”

OF IRRITABILITY.

(Continued.)

(1.) **W**E are told by Haller that *irritability* is resident in the muscular fibre, and *sensibility* in the nerve; and as far as this last property is indicative of the presence of nervous matter, or *irritability* characteristic of muscularity, this distinction is most probably true: for we do not find the nervous fibre itself *contractile*, nor do I apprehend that we should find any *sensibility* in a muscular part which was destitute of nerve. But I suspect that, under such circumstances, it would be also destitute of *irritability*. And therefore, although this property may reside in the muscular fibre only, yet it does not necessarily follow that it exists independently of the nervous system. If it do so, the proof of this still remains to be adduced;

and as that evidence seems to depend on an experiment which does not appear to be practicable^m, the various circumstances which militate against the opinion in question, will continue to do the same ; and although they may not be sufficient to refute that opinion, they will, at least, render it doubtful.

(2.) Those who contend that the irritable principle is not derived from the nerves, adduce another circumstance, which at first appears to give a considerable degree of credit to their opinion. This circumstance refers

^m In the first place, this experiment should be made on the living animal: and secondly, all communication should be completely cut off between the nervous system and some muscular part which may be made the subject of the experiment. This interception, however, cannot be complete without separating even the most minute nervous fibrillæ from every muscular fibre, so as to prevent any anastomosing communication between the parts. If, after such a complete separation, the irritability *continued the same*, then it might be fairly inferred that the irritable power exists independently of the nervous system. But this complete separation of the nerves from the muscular fibres, requires

to a paralytic limb which will sometimes manifest a degree of irritability, although there is a loss of motion and of sensation. But on the other hand, those effects which take place in consequence of the morbid changes which the nerves may undergo, cannot with propriety be deemed as conclusive evidence against a theory which has no kind of reference to disease; but, on the contrary, supposes the system in a healthy condition.

It is not in place here, nor is it essential, to inquire what may be the particular state or condition of these organs, when from diseased changes they are no longer capable

a degree of nicety in the art of dissection, such as the most skilful anatomist can never reach; nor, perhaps, could an animal sustain such an injury to its frame without the loss of life.

The nerves are so abundantly distributed throughout a muscle, that we cannot touch any part, even with the smallest pointed instrument, without feeling it in a greater or less degree; and as the whole muscular substance is irritable, it is probable that the nerves form a constituent part of the muscular fibres, and that they impart to these that principle upon which their irritable power depends.

of conveying to the mind those sensations consequent upon mechanical impressions, or when from such changes all communication is intercepted between the *muscles* and the *will*^a.

It may, however, be necessary to observe, that there is a state of palsy in which both the powers of motion and sensation are lost; and another in which there is some degree of sensation in the part affected, but no power of motion. Hence, whatever may be the proximate cause of *paralysis*, under either or both of these circumstances, it is very evident, that the nerves may be so partially affected as to perform only a part of their original functions; or, in other words, they may be

^a When a part is affected by any external impulse and we are conscious of it, a kind of compound action takes place, and an interval of time must necessarily elapse before that action is complete, and sensation follows: though, perhaps, that interval is too short for our distinct perception of it. This impulse, or exciting cause of sensation, is quickly transmitted to the mind through the medium of the nerves; and the mind instantly referring to the part impressed, we become

capable of furnishing only to a certain degree the principle of irritability, and yet, at the same time, be unfit to transmit to the sensorium the impulse or impression which may be made on the part to which the diseased nerves are distributed; and, as the mind is consequently prevented from making the reference before noticed, it cannot be conscious of any sensation in the parts affected, although they may be irritable to a certain degree.

(3.) This is corroborated by the temporary paralysis which is often induced in consequence of mechanical injuries to the nerves. When the injury is so great as to be conscious of the particular sensation which is excited. It is upon the same principle that we are enabled to perform those various actions connected with muscular exertion. If we *will* to extend the arm or bend the leg, we do this by means of a particular set of muscles which are under the control of the *will*, in consequence of the communication between those parts and the mind, through the medium of the nerves.

occasion such an effect, it prevents for a time a sufficient supply of that *something* which renders the part *irritable*, and which *something* we call *nervous energy*°. Now, some time is required to produce a total abstraction of this from any part, and the same time must also elapse before the irritability is likewise completely destroyed. The *nervous energy* may, however, be at so low an ebb, as that the same exciting causes which were before capable of calling forth the action of the part even to a violent degree, will be at this time insufficient to produce any visible effect. This was the case at a particular period after the experiment, before related, had been made^p; and it should also be observed, that when the action of the muscle could

° There may be a partial supply of nervous energy by some anastomosing branches of nerves which we may not be able to trace; but that supply not sufficient to make the part appear irritable.—*Vide* note c, page 59.

^p *Vide* note c, page 58.

not be excited by electricity, the animal was incapable of making any use of his leg; but after several days had elapsed, the muscle began to be susceptible of former impressions, and the limb became at last as useful to the animal as it was before the nerves were cut through.

All these circumstances are very easily accounted for, and the explanation of them is, no doubt, already anticipated by those who are acquainted with the resources of Nature in repairing injuries.

We know it is a law in the animal œconomy, that when living parts are divided, the blood which is effused between them, becomes the bond of their union, and is ultimately converted into the nature of the original part⁹.

⁹ *Vide Philosophical Transactions for 1795. "An Experimental Inquiry concerning the Reproduction of Nerves, by DOCTOR HAIGTON;" who proves that "nerves are not only capable of being united, when divided, but that the new-formed substance is really and truly nerve."*

Now, when the nerves were cut through in the experiment related before, the muscle to which they were distributed was possessed of a certain degree of *nervous energy*. But some time is necessarily required to produce a total abstraction of this from any part, and before the whole of it was expended from the muscle, the blood which was effused between the divided extremities of the nerves was beginning to be converted into the nature of these. As soon as this process was begun, there was a fresh, though, as yet, only a small supply of *nervous energy* conveyed to the muscle through the medium of the *new-formed nervous substance*; but as the nervous union advanced, the muscle acquired more and more nervous energy, until at last the regular functions of nerves were re-established, and the proper action of the limb completely restored.

From this experiment, as well as the various other circumstances which have been noticed on this very curious subject, there

appears to be great reason to infer, that the nerves give to parts that principle upon which their *sensitive* and *irritable* powers depend.

THE END.

